California's Flood Future

Recommendations for Managing the State's Flood Risk

Attachment H:
Practicing Flood Management Using An Integrated Water Manamgnet Approach

PUBLIC REVIEW DRAFT April 2013

California's Flood Future is provided to help inform local, State, and Federal decisions about policies and financial investments to improve public safety, foster environmental stewardship, and support economic stability

FloodSAFE CALIFORNIA

PUBLIC SAFETY ENVIRONMENTAL STEWARDSHIP ECONOMIC STABILITY

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STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

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PUBLIC DRAFT

Attachment H: Practicing Flood Management Using an Integrated Water Management Approach

April 2013

Photographs in this text are courtesy of the following agencies:

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Acronyms and Abbreviations

BMP	best management practice
Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CEAC	County Engineers Association of California
CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento – San Joaquin River Delta
DWR	California Department of Water Resources
FEMA	Federal Emergency Management Agency
Flood Future Report	*California's Flood Future: Recommendations for Managing the State's Flood Risk*
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
IWM	Integrated Water Management
IWRM	Integrated Water Resources Management
IWRP	Integrated Water Resources Planning
NFIP	National Flood Insurance Program
O&M	operation and maintenance
OMRR&R	operation, maintenance, repair, rehabilitation, and replacement
RWMG	Regional Water Management Group
SCVWD	Santa Clara Valley Water District
SFMP	Statewide Flood Management Planning
SPFC	State Plan of Flood Control
SSIA	State Systemwide Investment Approach
TM	technical memorandum
USACE	United States Army Corps of Engineers
WRMP	Water Resources Management Plan

Acronyms and Abbreviations

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1.0 Introduction

1.1 Background

California is at risk for catastrophic flooding. All 58 California counties have experienced at least one flood event with significant consequences in the last 20 years, resulting in loss of life, and billions of dollars in damages. This report, *California's Flood Future: Recommendations for Managing the State's Flood Risk* (Flood Future Report), is the first product of the Statewide Flood Management Planning (SFMP) Program. The Program was developed under the FloodSAFE Initiative to expand California's flood management planning statewide. Specifically, the purpose of the SFMP Program is to make recommendations to inform flood management policies and investments in the coming decades by:

- Promoting a clear understanding of flood risks in California
- Garnering active support for partnerships at the local, tribal, State, and Federal levels[1]
- Coordinating with other California Department of Water Resources (DWR) planning efforts
- Identifying strategies and feasible next steps to better incorporate flood management into Integrated Water Management (IWM)
- Promoting an IWM approach for flood management solutions

The initial work of the SFMP Program was to collect information in support of the Flood Future Report, as well as to build unique partnerships with local flood management agencies, the County Engineers Association of California (CEAC), Federal Emergency Management Agency (FEMA), and the United States Army Corps of Engineers (USACE). Throughout the Flood Future Report, determinations about specific flood terms were made that may not represent the specific terms used by partner agencies. These are described in Textbox 1-1. A description of the Flood Future Report components, organization, and layout is provided in Appendix A.

1.2 Purpose

The purpose of this technical memorandum (TM), presented as Attachment H to the Flood Future Report, is to provide an overview of flood management in California using an IWM approach. This TM is focused on illustrating how flood management has evolved over time and is moving toward an IWM approach. Using an IWM approach to flood management will help flood management and other resource agencies address the complex set of demands and challenges such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness, all of which complicate project implementation.

[1]Hereafter in this document, the mention of governmental agencies is implicit to include tribal entities.

In this TM, when an IWM approach is referenced, it is considered to include a flood management aspect. An IWM approach does not always require a flood component; however, the focus of the Flood Future Report is flood management, so this consideration is appropriate. It is also important to note that not every flood management project can be developed using an IWM approach due to the need to prioritize public safety and property protection, especially during and immediately following a flood emergency.

1.3 Organization

This TM is organized to provide a description of traditional flood management, demonstrate how agencies at all levels are evolving to an IWM approach, provide an overview of IWM approaches that includes benefits and challenges to implementation, and findings and recommended actions for successfully implementing this approach. Throughout the document, nine brief case studies are used to illustrate a successful IWM approach. Detailed information about each of these case studies is provided in Appendix E. In some instances, these case studies represent portions of larger projects, thus costs and other information presented for the case studies are not consistent with all projects listed in Appendix E. Some of the case studies represent projects that have been completed in the past but are provided as good examples of an IWM approach.

Specifically, this TM is organized in the following sections and appendices.

- Section 1 – Introduction
- Section 2 – Traditional Flood Management
- Section 3 – An IWM Approach
- Section 4 – Strategies and Management Actions for Practicing Flood Management with an IWM Approach
- Section 5 – Benefits of an IWM Approach to Flood Management
- Section 6 – Currently Planned IWM Projects
- Section 7 – Findings and Recommended Actions
- Section 8 – References
- Appendix A: Flood Future Report Components
- Appendix B: Management Action Description
- Appendix C: Planned IWM Projects in California
- Appendix D: USACE IWM Projects in California
- Appendix E: Detailed IWM Case Studies
- Appendix F: Glossary

Textbox 1-1: Agencies Differ in Flood Terminology

One of the challenges in a multi-agency effort is resolving language and culture differences between agencies. Staff from both USACE and DWR who are responsible for developing this report have made a conscious choice to adopt certain terminology throughout the documents.

As an example, USACE has adopted ***flood risk management*** as the term to describe a broad flood program that encompasses planning, construction, and operation, maintenance, repair, rehabilitation, and replacement (*OMRR&R*). DWR executes a similar broad program, largely through its Flood Management Division. As a result, DWR uses the term ***flood management*** in much the same way USACE uses *flood risk management*.

Another term used throughout this document is ***100-year flood*** (or some other *x*-year flood). Although these terms are commonly used, both USACE and DWR prefer using ***1 percent chance flood*** (or a 1-in-100 chance event) to describe a flood that has a 1 percent chance of occurring in any given year. However, legislative language from 2007 directing DWR to undertake new planning using bond proceeds uses 100-year flood.

For Federally funded projects, the definition of operation and maintenance (***O&M)*** includes the local entity's financial obligation to ***OMRR&R*** of the implemented project. OMRR&R is a non-Federal responsibility when local, regional and/or State entities partner on a Federal project. DWR typically uses O&M to refer simply to operation and maintenance, although repair and rehabilitation are sometimes included depending on project specifics. References to O&M provided in this report include OMRR&R responsibilities when the project is a Federal/non-Federal partnership.

For this report, both agencies agreed that, although language and cultural differences remain, it is more important to focus on the shared responsibility of performing our flood risk management or flood management missions rather than the use of specific phrases not in each agency's respective culture. A glossary is included to help the reader understand specific terms used by flood professionals and those terms that are used to define specific agency missions.

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2.0 Traditional Flood Management

2.1 History of Flood Management

Floods are naturally occurring phenomena in California, which can be beneficial to natural systems. Floods can keep erosion and sedimentation in natural equilibrium, replenish soils, recharge groundwater, filter impurities, and support a variety of riverine and coastal floodplain habitats for some of California's most sensitive species. However, when floods occur where people live and work, the results can be tragic, including loss of lives and devastating economic impacts caused by damaged critical infrastructure, valuable agricultural land taken out of production, damaged habitats, and disruptions to California's water supply system. Flood management, in this report, includes policies and practices related to educating the public and preparing for, mitigating damages of, responding to, and recovering from flooding that creates risk for people and valued resources, as well as protecting the natural and beneficial functions of floodplains to the maximum extent practicable.

Floodplains are flat or nearly flat lands adjacent to streams or other bodies of water that are periodically inundated. By definition, floodplains also include lands adjacent to and behind levees or other flood management structures.

In the 1800s, flood management was the responsibility of individual landowners (Kelley, 1998). This attitude changed when catastrophic floods occurred in the late 1800s and early 1900s, resulting in a series of flood control statutes that increased State and Federal government's responsibility for flood management. These statutes were the impetus for construction of numerous flood management structures including dams, levees, reservoirs, and floodwalls.

In the 1960s, studies found that damage due to floods was increasing and that continued urban development in floodplains was increasing flood risk. As a result, local, State, and Federal agencies began developing policies and programs that managed floodplains in addition to implementing structural solutions for controlling floodwater (FEMA, 2010).

Residual Risk is the likelihood of damage or other adverse consequences remaining after flood management actions are taken. Flood risk can never be 100 percent eliminated.

Historically, flood management focused on developing narrowly focused flood infrastructure projects to reduce the chance of flooding in a specific geographic area. This infrastructure works effectively to reduce the chance of flooding and avoid damage to lives and property, but certain infrastructure can also alter and confine natural watercourses. These alterations can lead to unintended consequences, such as loss of ecological function and redirection of flood risks upstream or downstream of projects. Also, traditional approaches to flood management have resulted in enabling urban and agricultural development within floodplains, placing property and people at risk of flooding, many of whom have inadequate awareness regarding residual flood risk.

Today, flood managers face an increasingly complex world of resource management issues, regulatory constraints, and diverse stakeholder demands. Many of these challenges did not exist when some of the original infrastructure

solutions were conceived and implemented. These challenges include increased environmental awareness, multiple agency jurisdictions, inadequate financing, and conflicting regulations and permitting requirements. The path forward for successful implementation of projects calls for a shift to IWM solutions as opposed to the narrowly focused projects of the past.

2.2 Issues Facing Flood Management Projects

Project development, implementation, and operation constraints have changed as societal values have evolved. Today, all projects, including flood management projects, face increased stakeholder involvement, land use constraints, changing regulatory requirements, and new environmental considerations.

Local, State, and Federal flood management agencies identified a number of issues facing project development and operation as part of the research used to develop the Flood Future Report. More than 140 public agencies responsible for flood management provided information. This effort is summarized in *Attachment E: Existing Conditions of Flood Management in California (Information Gathering Findings)*.

Specific issues impacting flood management projects include the following:

- **Projects require extensive stakeholder involvement, which increases project planning costs.** Stakeholders have become more educated about project development and environmental requirements. Successful projects require proper engagement of a diverse set of stakeholders. The cost associated with stakeholder engagement activities must be included in planning and implementation costs.
- **Flood management responsibility is fragmented**. Responsibilities for planning, administering, financing, and maintaining flood management facilities and emergency response programs are usually spread among several agencies or between departments within a large agency. More than 1,300 agencies have some responsibility for flood management in the state. Flood management responsibilities are often spread out within and between these agencies.
- **Different methodologies and inadequate data make risk assessment complex and costly to complete.**
- **Land use decisions may not adequately prioritize public safety.** Uninformed residents and policymakers can make decisions that inadvertently put people and property at increased risk. In some cases, providing adequate space for flood management facilities to meet existing and future needs during the development approval process would reduce flooding impacts. Internal and intra-agency coordination is important when local agencies make development decisions. Improving coordination within and between agencies could inform the potential land use decisions to avoid adverse flood impacts. Even with new requirements that call for flood

considerations in General Plans, flood managers are not always included in land use discussions.

- **Delayed permit approvals and complex permit requirements are obstacles to flood risk reduction.** Many agencies wait years for permits, resulting in poorly maintained projects and missed funding opportunities for new projects. Often, agencies face conflicting or confusing requirements regarding project permits. Also, regulatory requirements to renew existing permits or obtain new permits frequently require extensive mitigation. This mitigation can greatly increase project costs and cause project delays.
- **Flood management projects are not prioritized from a systemwide or multibenefit perspective.** State and Federal flood management funding has traditionally been provided to local projects by analyzing a narrowly focused and localized set of benefits. In addition, funding levels for flood management are often set without regard to a systemwide prioritization of needs.
- **Lack of reliable, sustained funding puts California at significant risk.** Inadequate funding for flood management maintenance, operations, and improvements makes flood risk reduction difficult or impossible for many local agencies. Agencies at all levels are facing funding constraints. Local agency funding is often based on county general funds, which have been impacted by the economic downturn and limited by restrictions from Proposition 218 (1996 Right to Vote on Fair Taxes Act). State funding for flood management has been tied to bond funding, much of which will be depleted by 2017. Reductions in Federal funding have occurred, resulting in potential reductions in funding levels for flood risk studies and projects.
- **Flood risk funding.** Funding for flood projects is based upon the potential that a significant flood will occur, rather than providing for day-to-day flood management needs.

These issues have led to an increase in the cost of flood management. Addressing these issues will require a move away from the traditional approach to developing flood management projects. The mitigation components of many projects are already moving flood management toward using an IWM approach. However, a true IWM approach requires coordination, collaboration, and inclusion of diverse objectives from the initiation of the project development process, rather than as a mitigation measure.

Thousand Palms, 2005

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3.0 An IWM Approach

In traditional flood management, the overarching purpose is to separate floodwaters from people and property that could be harmed. In contrast, integrated water management (IWM) seeks a balance among exposure of people and property to flooding, the quality and functioning of ecosystems, the reliability of water supply and water quality, and economic stability (including both economic and cultural considerations). This shift changes the focus of flood management from a local context to a systemwide context.

3.1 What is an IWM Approach?

IWM is a strategic approach that combines specific flood management, water supply, and ecosystem actions to deliver multiple benefits. This approach relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental science, public policy, and public relations. An IWM approach also promotes system flexibility and resiliency to accommodate changing conditions such as regional requirements, local preferences, ecosystem needs, climate change, flood or drought events, and financing capabilities.

Using an IWM approach is not a one-time activity. Long-term commitments and alignment among the responsible public agencies are necessary to create sustainable, affordable water resource systems. Achieving agency alignment and regional collaboration can be a challenge because an IWM approach requires striking a balance between objectives that are sometimes competing. However, using an IWM approach builds on broad stakeholder support and can lead to faster project completion, as well as access to additional funding sources.

IWM is an evolving approach embraced by many public and private entities around the nation and the world. As a result, nuanced differences exist in definitions of IWM, such as:

- Integrated Regional Water Management (IRWM), which is the application of IWM principles on a regional basis
- Integrated Water Resources Management (IWRM), which is another term used to describe IWM

Some of the different definitions of IWM are provided in the samples below.

IWM Project along Guadalupe River

United Nations

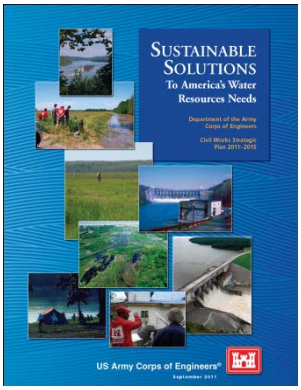
The United Nations uses the widely accepted definition of IWRM developed by the Global Water Partnership. The Global Water Partnership was founded in 1996 by the World Bank, the United Nations Development Programme, and the Swedish International Development Cooperation Agency to foster IWRM. The Global Water Partnership's definition of IWRM states (GWP, 2012):

> *IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*

Republic of South Africa, Department of Water Affairs

The Republic of South Africa, Department of Water Affairs uses the widely accepted definition of IWRM from the Global Water Partnership, as well as the following (RSA, 2013):

> *Integrated Water Resource Management (IWRM) is simultaneously a philosophy, a process, and an implementation strategy to achieve equitable access to, and sustainable use of, water resources by all stakeholders at catchment (watershed), regional, national, and international levels, while maintaining the characteristics and integrity of water resources at the catchment (watershed) scale within agreed limits.*



U.S. Army Corps of Engineers

As part of the *USACE Civil Works Strategic Plan 2011- 2015*, the USACE has developed an overarching strategy that embraces IWRM. IWRM is defined as a holistic focus on water resource challenges and opportunities that reflects coordinated development and management of water, land, and related resources while maximizing economic services and environmental quality, and ensuring public safety while providing for the sustainability of vital ecosystems (USACE, 2012).

Department of Water Resources, IRWM Strategic Planning Team

IRWM, in its broadest sense, is a philosophy and practice of coordinating the management of water and related resources for the purpose of maximizing economic and societal benefits while maintaining the sustainability of vital ecosystems.

Santa Clara Valley Water District

The Santa Clara Valley Water Distract (SCVWD) implements the concept of IWM through a comprehensive Water Resources Management Plan (WRMP) (SCVWD, 2013). The SCVWD comprehensive WRMP outlines key issues and provides a framework for community understanding of policies related to water supply, natural flood protection, and water resource stewardship within the agency's boundaries. SCVWD's mission statement also encompasses the concept of an IWM approach (SCVWD, 2012). As stated, the mission is to:

. . . provide for a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally sensitive manner for current and future generations.

Los Angeles County Department of Public Works

The Los Angeles County Department of Public Works is adopting a sustainable business approach that embraces the concepts of IWM in its 2012 Strategic Plan (LACDPW, 2012). This approach involves using a more holistic, creative, and collaborative method to solving problems, and it requires a balanced approach to deliver projects, programs, and services in an environmentally and socially responsible way that ensures the long-term health and well-being of the environment and the local community.

3.2 Evolution of Flood Management Toward an IWM Approach

Although different agencies may have different characterizations or use different acronyms to describe IWM, agencies around the state are moving toward using this approach. This section will describe how the approaches to flood management that are used by local, State, and Federal agencies are evolving.

3.2.1 USACE's IWM Approach

The Flood Control Act of 1936 declared that flood risk management (formerly flood control) was a national priority because floods constituted a potential menace to national welfare. This act established an enormous commitment by the Federal government to reduce the risk of flooding to people and property. Congress has authorized the USACE to plan, engineer, and construct hundreds of flood risk management projects consisting of hundreds of miles of levees, flood walls, and channel improvements, as well as approximately 375 major dams and reservoirs nationwide (USACE, 1988). These efforts have saved billions of dollars in property damage and protected millions of people from death, injury, and other related health issues.

Since 1977, Federal agencies have included IWM principles in flood management. Today, USACE incorporates IWM principles in its definition of floodplain management (see sidebar). As part of the USACE Civil Works Strategic Plan 2011-2015, the USACE is embracing an overarching strategy that advocates an

Floodplain Management is a continuing process, involving both Federal and non-Federal actions that seek a balance between use and environmental quality in the management of the inland and coastal floodplains as components of the larger human communities. The flood damage reduction aspects of floodplain management involve modifying floods and modifying the susceptibility of property to flood damages. The former embraces the physical measures commonly called "flood control;" the latter includes regulatory and other measures intended to reduce damages by means other than modifying flood waters. By guiding floodplain land use and development, floodplain regulations seek to reduce future susceptibility to flood hazards and damages consistent with the risk involved and serve in many cases to preserve and protect natural floodplain values.

USACE EP 1165-2-1

IWRM approach for projects. This plan identifies six cross-cutting strategies to assist with implementing an IWRM approach; these strategies are as follows:

- **Systems Approach** – Develop water resources planning and management on a watershed scale, using systemwide analysis methods and tools to understand, assess, and model the interconnected nature of hydrologic systems (e.g., watersheds) and the economic and ecologic systems they support, and to identify and evaluate management alternatives from both time (life-cycle) and function (multipurpose) perspectives.
- **Collaboration and Partnering** – Build and sustain collaboration and partnerships at all levels to leverage funding, talent, data, and research from multiple agencies and organizations.
- **Risk-Informed Decision Making and Communication** –Develop and employ risk- and reliability-based approaches that incorporate consequence analysis, especially risks to humans; identify, evaluate, and forestall possible failure mechanisms; and quantify and communicate residual risk.
- **Innovative Financing** – Think beyond traditional government appropriations and seek innovative arrangements such as public-private partnerships, revised funding prioritizations, and other appropriate funding mechanisms to develop and sustain the infrastructure for the nation's water resources.
- **Adaptive Management** – Promote and employ adaptive management, a process that promotes flexible decision making that can be adjusted in the face of risks and uncertainties (such as those presented by climate change) as outcomes from management actions and other events become better understood through monitoring and improved knowledge.
- **State-of-the-Art Technology** – Embrace new and emerging technology to its fullest advantage. Invest in research that improves the resiliency of structures, assists in updating design criteria, and improves approaches toward planning and design (USACE, 2011).

Currently, USACE faces challenges to implementation of an IWM approach, including program and funding policies and procedures, cost-sharing requirements of non-Federal sponsors, and the need to clearly define the USACE roles in flood risk management and ecosystem restoration.

An IWM approach to a project is exemplified in the South San Francisco Bay Shoreline Project, briefly described in Case Study 1. For this project, the USACE has partnered with the California State Coastal Conservancy, U.S. Fish and Wildlife Service, and the SCVWD (for more information, see Case Study 1).

Case Study 1	
Project Name:	South San Francisco Bay Shoreline Study

Project Description:

The South San Francisco Bay Shoreline Study is located in the southern San Francisco Bay Area and covers approximately 26,000 acres of former tidal marsh. This study is investigating the feasibility of a combined flood risk management and ecosystem restoration project, as well as public access opportunities. Tidal flooding in the area is due to historic subsidence (up to 13 feet in some areas), which is projected to increase due to sea level rise.

In the San Francisco Bay- Delta Estuary, an estimated 85 percent of the historical tidal marshes have been filled or significantly altered during the past two centuries. These wetland habitats, including the salt ponds, tidal marshes, sloughs, mudflats, and open bay, are used by large populations of waterfowl and shorebirds, harbor seals, and a number of threatened and endangered species. The project is being developed in phases.

San Francisco Bay Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Project benefits include:

- Reduced potential economic damages due to tidal flooding.
- Reduced risk to public health, human safety, and the environment due to tidal flooding.
- Increased contiguous marsh area to restore ecological function and habitat quantity, quality, and connectivity.

Success Factors: Diverse funding sources, phased approach.

Project Status

The total cost of the study is approximately $19 million, and the estimated project cost is on the order of $500 million. Feasibility studies and early implementation stages are funded and underway, although design and construction phases are currently unfunded.

Typical Natural Tidal Marshland in San Francisco Bay Area

Source: 2012-2016 5-Year Capital Improvement Program, 2011, SCVWD

3.2.2 DWR's IWM Approach

In 1956, the California Legislature passed a bill creating the Department of Water Resources. DWR was created to plan, design, construct, and oversee the building of the nation's largest State-built water development and conveyance system. Today, DWR protects, conserves, develops, and manages much of California's water supply, including the State Water Project, which provides water for 25 million residents, farms, and businesses. DWR also works to prevent and respond to floods, droughts, and catastrophic events that would threaten public safety, water resources and management systems, the environment, and property.

Today, even as the concept of IWM is evolving, DWR is actively promoting IWM approaches through many of its ongoing programs. These programs include:

- FloodSAFE California Initiative, which uses an IWM approach to improve public safety
- The California Water Plan, which develops an IWM Strategic Plan for the state

DWR IRWM Planning

DWR has supported IRWM with grants and technical services to regional water management groups (RWMGs) statewide. Forty-eight RWMGs now cover 87 percent of the state's geographic area and 99 percent of the population. The individual IRWM regions and RWMGs can be found at http://www.water.ca.gov/irwm/grants/index.cfm.

- IRWM planning, which has provided technical assistance and grants to support implementation of an IWM approach at a regional level

For example, DWR and other State agencies have recently developed IWM solutions in the following plans:

- Central Valley Flood Protection Plan
- Bay-Delta Conservation Plan
- Climate Change Initiative
- The Delta Stewardship Council's Delta Plan
- Strategic Plan for the Future of Integrated Regional Water Management

The Vic Fazio Wildlife Area Project demonstrates a long-term, State-funded, flood management project that is evolving to acknowledge and expand multiple benefits, including flood management, agricultural land use, and habitat restoration (see Case Study 2 for additional information).

Case Study 2

Project Name: Vic Fazio Wildlife Area

Project Description:

The Yolo Bypass near the project area is used to carry floodwater from major northern California rivers, diverting flows around low-lying communities in the Sacramento-San Joaquin River-Delta (Delta) and the City of Sacramento. The project area serves many functions, including agriculture, wildlife habitat, fish spawning habitat, and flood control.

The Vic Fazio Wildlife Area project consists of integrated management actions to:

- Provide a 41-mile-long swath of agricultural land that conveys floodwater to the Delta during times of heavy flows
- Provide for multiple uses along the bypass that supports a variety of land uses and resources, including agricultural production
- Provide regional recreational public access
- Provide an extensive levee system of flood control for the surrounding area
- Provide ecosystem benefits for rare and endangered species

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits:

This project provides multiple benefits, including:

- Provides flood protection for downstream communities
- Provides agricultural and recreational uses
- Improves ecosystem health and connectivity, including wetland, upland, grassland, and riparian habitats

Success Factors: Transparency, facilitation of permitting approach, multiple benefits, agency alignment.

Project Status

The project was designed to divert water during times of large flows through a series of weirs and channels and has been functioning since it was originally constructed following the adoption of the Sacramento River Flood Control Project by Congress in 1917. The project has continued to be adapted and expanded, based on the changing needs of the region. The California Department of Fish and Wildlife (CDFW) began acquiring property in the area in 1992, and CDFW continues to expand this area.

Photographer: David Feliz

3.2.3 Local Agencies' Use of an IWM Approach

More than 1,300 flood management agencies[2] throughout the state are responsible for operation and maintenance (O&M), as well as repair, rehabilitation, and replacement (OMRR&R) of nearly 20,000 miles of levees, more than 2,000 dams, more than 1,000 debris basins, more than 100 major reservoirs, and many other facilities. These facilities have been developed over time using not only traditional flood management but also some IWM approaches. Initially, most flood management agencies were established by landowners in the region to address an ongoing flooding problem. These agencies either developed infrastructure alone or partnered with State and Federal agencies to build facilities.

Responsibilities of these agencies have evolved, and the types of agencies involved in flood management have expanded. Agencies with flood management responsibilities now include special districts, cities, counties, levee districts, reclamation districts, and tribes. This complex network of agencies has resulted in agency roles and responsibilities that sometimes overlap and occasionally have conflicting mandates.

Today, these agencies face a number of challenges with implementing flood management projects. The information gathering effort for the Flood Future Report (see *Attachment E: Existing Conditions of Flood Management in CA (Information Gathering Findings*) revealed the following conditions:

- Many projects are moving toward an IWM approach due to the mitigation requirements for permitting.
- Some agencies have fully embraced an IWM approach and include IWM principles in agency mission statements.
- Although most agencies are aware of IWM approaches and have considered an IWM project, the larger-sized urban agencies are generally the most active in planning and implementing IWM projects. Santa Clara Valley Water District, Sacramento Area Flood Control Agency, and Santa Ana Watershed Protection Authority are examples of large, urban agencies that have implemented projects using an IWM approach.
- Smaller or more rural agencies often struggle with developing projects using the IWM approach.

An example of a local agency-sponsored project using an IWM approach is the Sun Valley Watershed Management Plan presented in Case Study 3.

[2] See *Attachment G: Risk Information Inventory* for a complete list of flood management agencies.

Case Study 3

Project Name: Sun Valley Watershed Management Plan

Project Description:

The Sun Valley watershed is located in the San Fernando Valley in the city of Los Angeles, approximately 14 miles northwest of downtown Los Angeles. It is a densely urbanized area, approximately 60 percent of which is dedicated to industrial and commercial use. This plan is being implemented using a phased approach with the following components:

- Construct debris basins, including the use of large-scale stormwater separation devices.
- Manage runoff through watershed management by increased vegetative cover and infiltration basins, minimizing impermeable surfaces.
- Improve the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.
- Manage municipal stormwater to provide regional or systemwide flood benefits.
- Increase local agency awareness of flood mitigation compliance, floodplain function, and grant application assistance through the Stakeholder Group.

Multiple Benefits and Success Factors

Benefits: This project has the following benefits:

- Improves stormwater management and reduces localized flooding
- Improves water quality of downstream receiving streams
- Increases water supply by capturing runoff
- Increases recreational opportunities via parks, trails, sporting facilities
- Improves wildlife habitat by restoring and connecting habitat corridors

Success Factors: Agency collaboration

Project Status

The Sun Valley Watershed Management Plan projects are being implemented in phases and are in various stages of securing funding. Completed phases of the project have costs totaling greater than $10 million. Additional projects are still pending, seeking final approvals and funding.

Chronic Street Flooding – Sun Valley Watershed

Source: Los Angeles County Department of Public Works, 1989

4.0 Strategies and Management Actions for Practicing Flood Management with an IWM Approach

Projects developed using an IWM approach have different components based on the type of flooding addressed, regional preferences, agencies involved, stakeholders involved, and funding available. An IWM approach to the practice of flood management is implemented by bundling different components or management actions together to achieve multiple project objectives.

Key elements to implementing an IWM approach apply to flood management, as well as to other water resource management practices.

4.1 Practicing an IWM Approach

One benefit of using IWM is that it encourages a systemwide perspective to solving flood issues along with an increased understanding of the cause and effect of different management actions. This moves solutions beyond simply reducing flood risk resulting from the 100-year flood event in compliance with NFIP requirements to an integrated approach that reduces flood risk and supports other objectives over a multitude of flood events. (A 100-year flood has a 1-in-100, or 1 percent, probability of occurring in any given year.) Traditional flood management approaches inadvertently allowed development in floodplains, putting people and property at risk. An IWM approach is balanced and leads to addressing a wide variety of needs. For example, projects are assessed based on the following attributes:

- Potential velocities and timing of flood flows, as well as resources that could be disturbed or damaged by those velocities and timings
- Depth and duration of floodwaters both during the event and after the event
- Ecosystem processes that could be either enhanced or diminished by projected flows
- Stability of floodways, including potential for scour, erosion, and sediment transport and deposition
- Opportunities for community and private access to and use of lands dedicated to the flood path
- Alternative or combined uses of the lands that make up the flood path
- Risks to the community should a flood occur, and recovery capabilities following a flood
- Water supply implications from the flood management system and operating conditions before, during, and after flood events

Flood Management as part of an Integrated Water Management Approach

IWM is an approach that combines specific flood management, water supply, and ecosystem actions to deliver multiple benefits. An IWM approach uses a collection of tools, plans, and actions to achieve efficient and sustainable solutions for the beneficial uses of water. An IWM approach reinforces the interrelation of different water management components—such as water supply reliability, flood management, and environmental stewardship—with the understanding that changes in the management of one component will affect the others. This approach applied to flood management looks at the benefits of flooding to natural systems. IWM acknowledges the importance and function of flooding as a natural part of the ecosystem and helps people to learn to live with and better understand the benefits of flooding. This approach promotes system flexibility and resiliency to accommodate changing conditions such as regional preferences, ecosystem needs, climate change, flood or drought events or financing capabilities.

An IWM approach requires unprecedented alignment and cooperation among public agencies, tribal entities, land owners, interest-based groups, and other stakeholders. It is not a one-time activity but rather an ongoing process. Also, this approach relies on blending knowledge from a variety of disciplines, including engineering, planning, economics, environmental science, public policy, and public information.

An IWM approach represents the future of flood management in California, with the goal to improve public safety, foster environmental stewardship, and support economic stability.

Today, flood management is evolving from narrowly focused traditional approaches toward an IWM approach. The flood management emphasis has shifted to this more integrated approach that includes a mix of multiple measures, including structural and nonstructural approaches. This more integrated approach enhances the ability of undeveloped floodplains and other open spaces to behave more naturally and absorb, store, and slowly release floodwaters during small and medium-sized events. Flood management as part of an IWM approach considers land and water resources on a watershed scale, employing both structural and nonstructural measures to maximize the benefits of floodplains and minimize loss of life and damage to property from flooding, and recognizing the benefits to ecosystems from periodic flooding. Flood management utilizes best management practices (BMPs), which are methods or techniques that are used in a variety of circumstances and fields, from stormwater management to land use planning, to yield superior results. The application of flood management approaches within the context of an IWM approach extends the range of strategies that could be employed beyond the traditional approach. Additionally, the approaches that could be implemented to manage flood risk within a hydrologic region or watershed will vary, depending on the physical attributes of the area, the presence of undeveloped floodplains, the type of flood hazards (e.g., riverine, alluvial fan, coastal), and the areal extent of flooding.

Although the primary purpose of flood management is public safety (i.e., reduce flood risk and reduce the impacts of flooding on lives and property), approaches to flood management can serve many purposes, and flood management is a key component of an IWM approach.

4.2 Management Actions

Flood management includes a wide range of management actions and can be grouped into four general approaches—Nonstructural Approaches, Restoration of Natural Floodplain Functions, Structural Approaches, Emergency Management, and Crosscutting Approaches. These approaches and the management actions within them serve as a toolkit of potential actions that local, State, and Federal agencies can use to address flood-related issues, and advance IWM.

These actions range from policy or institutional changes to operational and physical changes to flood infrastructure. Such

actions are not specific recommendations for implementation; rather, they serve as a suite of generic management tools that can be used individually or combined for specific application situations. A variety of management actions can be bundled together as part of a single flood management project (see accompanying project case studies in Appendix E: Detailed IWM Case Studies). Management actions also can be integrated with other resource management strategies under other objectives (e.g., water supply, water quality, ecosystem restoration, and recreation) to create multibenefit projects.

More than 100 flood management actions were identified by the Flood Future Report. The Flood Future Report used as a basis the Central Valley Flood Protection Plan (CVFPP) management actions that were applicable to the Central Valley. These were then broadened to apply to other regions of the state and to different types of flood hazards. The four general categories of management actions are summarized in this section. A detailed list of management actions and their descriptions is in Appendix B.

4.2.1 Nonstructural Approaches

Nonstructural approaches to flood management include land use planning and floodplain management.

Land Use Planning

Land use planning employs policies, ordinances and regulations to limit development in flood-prone areas and encourages land uses that are compatible with floodplain functions. This can include policies and regulations that restrict or prohibit development within floodplains, restrict size and placement of structures, prevent new development from providing adverse flood impacts to existing structures, encourage reduction of impervious areas, require floodproofing of buildings, and encourage long-term restoration of streams and floodplains.

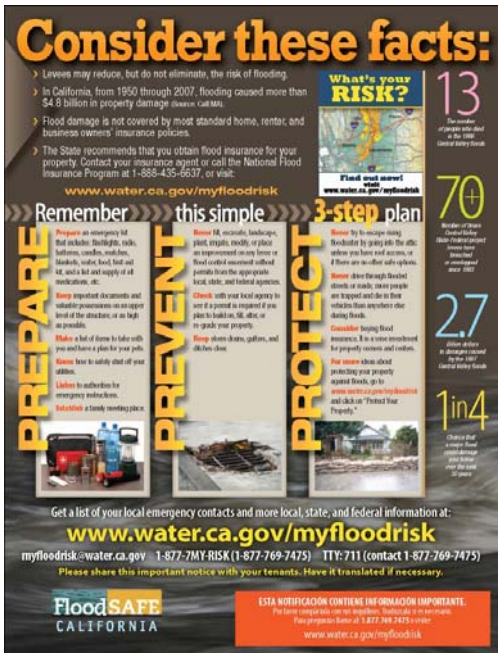
Construction within the Floodplain (survey pole denotes elevation of 100-year flood event)

Floodplain Management

Floodplain management generally refers to nonstructural actions in floodplains to reduce flood damages and losses. Floodplain management actions include:

- **Floodplain Mapping and Risk Assessment –** Floodplain mapping and risk assessment serve a crucial role in identifying properties that are at a high risk to flooding. Accurate, detailed maps are required to prepare risk assessments, guide development, prepare plans for community economic growth and infrastructure, utilize the natural and beneficial function of floodplains, and protect private and public investments. Development of needed technical information includes topographic data, hydrology, and hydraulics of streams and rivers, delineation of areas subject to inundation, assessment of properties at risk, and calculation of probabilities of various levels of loss from floods.

- **Land Acquisitions and Easements –** Land acquisitions and easements can be used to restore or preserve natural floodplain lands and to reduce the damages from flooding by preventing urban development. Land acquisition involves acquiring full-fee title ownership of lands from a willing buyer and seller. Easements provide limited-use rights to property owned by others. Flood easements, for example, are purchased from a landowner in exchange for perpetual rights to periodically flood the property when necessary or to prohibit planting certain crops that would impede flood flows. Conservation easements can be used to protect agricultural or wildlife habitat lands from urban development. Both land acquisitions and easements generally involve cooperation with willing landowners. Although acquisition of lands or easements can be expensive, they can reduce the need for structural flood improvements that would otherwise be needed to reduce flood risk. Maintaining agricultural uses and/or adding recreational opportunities where appropriate provide long-term economic benefits to communities and the State.



DWR Flood Risk Notification Program Flyer, 2012

- **Building Codes and Floodproofing –** Building codes and floodproofing include specific measures that reduce flood damage and preserve egress routes during high-water events. Building codes are not uniform; they vary across the state based on a variety of factors. Example codes could require floodproofing measures that increase the resilience of buildings through structural changes, elevation, or relocation and the use of flood resistant materials.
- **Retreat –** Retreat is the permanent relocation, abandonment, or demolition of buildings and other structures. Retreat can be used in a variety of settings from floodplains to coastal areas. In coastal regions, this action would allow the shoreline to advance inward, unimpeded in areas subject to high coastal flooding risks, high erosion rates, or future sea level rise. Integrating recreation uses into retreat areas along the shoreline provides economic uses for these buffer lands.
- **Flood Insurance –** Flood insurance is provided by the Federal government via the NFIP to communities that adopt and enforce an approved floodplain management ordinance to reduce future flood risk. The NFIP enables property owners in participating communities to purchase subsidized insurance as a protection against flood losses. If a community participates in the voluntary Community Rating System and implements certain floodplain management activities, the flood insurance premium rates are discounted to reflect the reduced flood risks.

- **Flood Risk Awareness (Information and Education) –** Flood risk awareness is critical because it encourages prudent floodplain management. Flood hazard information is a prerequisite for sound education in understanding potential flood risks. If the public and decision makers understand the potential risks, they can make decisions to reduce risk, increase personal safety, and expedite recovery after floods. Effective risk awareness programs are critical to building support for funding initiatives and to building a connection to the watershed.

Restoration of Natural Floodplain Functions

This strategy recognizes that periodic flooding of undeveloped lands adjacent to rivers and streams is a natural function and can be a preferred alternative to restricting flood flows to an existing channel. The intent of natural floodplain function restoration is to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and slowly release floodwaters, to enhance ecosystem, and to protect flora and fauna communities. Natural floodplain function conservation and restoration actions can include both structural and nonstructural measures. To permit seasonal inundation of undeveloped floodplains, some structural improvements (e.g., weirs) might be needed to constrain flooding within a defined area along with nonstructural measures to limit development and permitted uses within those areas subject to periodic inundation. Actions that support natural floodplain and ecosystem functions include:

- **Promoting Natural Hydrologic, Geomorphic, and Ecological Processes –** Natural hydrologic, geomorphic, and ecological processes are key components of promoting natural floodplain and ecosystem functions**.** Human activities (including infrastructure such as dams, levees, channel stabilization, and bank protection) have modified natural hydrological processes by changing the extent, frequency, and duration of natural floodplain inundation. These changes disrupt natural geomorphic processes such as sediment erosion, transport, and deposition, which normally cause channels to migrate, split, and rejoin downstream. These natural geomorphic processes are important drivers in creating diverse riverine, riparian, and floodplain habitat to support fish and wildlife, and in providing natural storage during flood events. Restoration of these processes might be achieved through setting back levees, restoring channel alignment, removing unnatural hard points within channels, or purchasing lands or easements that are subject to inundation.
- **Protecting and Restoring Quantity, Quality, and Connectivity of Native Floodplain Habitats –** Quantity, quality, and connectivity of native floodplain habitats are critical to promote natural floodplain and ecosystem functions**.** In some areas, native habitat types and their associated floodplain have been lost, fragmented, and degraded. Lack of linear continuity of riverine, riparian habitats, or wildlife corridors, impacts the movement of wildlife species among habitat patches and results in a lack of

diversity, population complexity, and viability. This can lead to native fish and wildlife becoming rare, threatened, or endangered. Creation or enhancement of floodplain habitats can be accomplished through setting back levees and expanding channels or bypasses, or through removal of infrastructure that prevents flood flows from entering floodplains. Coastal wetlands have been severely reduced, resulting in a loss of habitat for freshwater, terrestrial, and marine plant species. Restoration of these habitats could provide a buffer against storm surges and sea level rise.

Invasive Species Reduction – Minimizing invasive species can help address problems for both flood management and ecosystems. Invasive species can reduce the effectiveness of flood management facilities by decreasing channel capacity, increasing rate of sedimentation, and increasing maintenance costs. Nonnative, invasive plant species often can out-compete native plants for light, space, and nutrients, further degrading habitat quality for native fish and wildlife. These changes can supersede natural plant cover, eliminate, or reduce the quality of food sources and shelter for indigenous animal species, and disrupt the food chain. Reductions in the incidence of invasive species can be achieved by defining and prioritizing invasive species of concern, mapping their occurrence, using BMPs for control of invasive species, and using native species for restoration projects.

4.2.2 Structural Approaches

Structural approaches to flood management include flood infrastructure, reservoir and floodplain storage and operations, and O&M.

Colusa Weir and Bypass – normal flow (above) and 1997 flood (below)

Flood Infrastructure

Flood infrastructure varies significantly based on the type of flooding. Flood infrastructure can include:

- **Levees and Floodwalls –** Levees and floodwalls are designed to confine flood flows by containing waters of a stream or lake. Levees are an earthen or rock berm constructed parallel to a stream or shore (or around a lake) to reduce risk from all types of flooding. Levees could be placed close to stream edges, or farther back (e.g., a setback levee). Ring levees could be constructed around a protected area, isolating the area from potential floodwaters. A floodwall is a structural reinforced-concrete wall designed and constructed to hold back floodwaters. Floodwalls have shallow foundations or deep foundations, depending on flood heights and soil conditions.
- **Channels and Bypasses –** Channels and bypasses convey floodwaters to reduce the risk of slow rise, flash, and debris-flow flooding. Channels can be modified by deepening and excavating the channel to increase its capacity, or lining the streambed and/or banks with concrete, riprap, or other

materials, to increase drainage efficiency. Channel modifications can result in increased erosion downstream and degradation of adjacent wildlife habitat, and often the modifications require extensive permitting. Bypasses are structural features that divert a portion of flood flows onto adjacent lands (or into underground culverts) to provide additional flow-through capacity and/or to store the flows temporarily and slowly release the stored water.

- **Retention and Detention Basins –** Retention and detention basins are used to collect stormwater runoff and slowly release it at a controlled rate so that downstream areas are not flooded or eroded**.** A detention basin eventually drains all of its water and remains dry between storms. Retention basins have a permanent pool of water and can improve water quality by settling sediments and attached pollutants.
- **Culverts and Pipes –** Culverts and pipes are closed conduits used to drain stormwater runoff. Culverts are used to convey streamflow through a road embankment or some other type of flow obstruction. Culverts and pipes allow stormwater to drain underground instead of through open channels and bypasses.
- **Coastal Armoring Structures, Shoreline Stabilization, and Streambank Stabilization –** Coastal armoring structures and shoreline stabilization reduce risk to low-lying coastal areas from flooding**.** Coastal armoring structures are typically massive concrete or earthen structures that keep elevated water levels from flooding interior lowlands and prevent soil from sliding seaward. Shoreline stabilization reduces the amount of wave energy reaching a shore or restricts the loss of beach material to reduce shoreline erosion rates. Types of shoreline stabilization include breakwaters, groins, and natural or artificial reefs. Streambank stabilization protects the banks of streams from erosion by installing riprap, matting, vegetation or other materials to reduce erosion.

Crescent City Breakwall, 2012

- **Debris Mitigation Structures –** For debris and alluvial flooding, Sabo dams, debris fences, and debris basins separate large debris material from debris flows, or the structures contain debris flows above a protected area. These structures require regular maintenance to periodically remove and dispose of debris after a flood. Deflection berms (or training berms) can be used to deflect a debris flow or debris flood away from a development area, allowing debris to be deposited in an area where it would cause minimal damage.

Reservoir and Floodplain Storage and Operations

Reservoir and floodplain storage and operations consist of:

- **Reservoir and Floodplain Storage –** Reservoir and floodplain storage provide an opportunity to regulate flood flows by reducing the magnitude of flood peaks occurring downstream. Many reservoirs are multipurpose and serve a variety of functions, including water supply, irrigation, habitat, and flood control. Reservoirs collect and store water behind a dam and release it after the storm event. Floodplain storage occurs when peak flows in a river are diverted to adjacent off-stream areas. Floodplain storage can occur naturally when floodwaters overtop a bank and flow into adjacent lands, or storage can be engineered using weirs, berms, or bypasses to direct flows onto adjacent lands.

Dominguez Gap Detention Basin and Wetlands

- **Storage Operations –** Storage operations optimize the magnitude and timing of reservoir releases. Storage operations can reduce downstream flooding by optimizing the magnitude or timing of reservoir releases, or through greater coordination of storage operations. Coordination can take the form of formal agreements among separate jurisdictions to revise reservoir release operations based on advanced weather and hydrology forecasts, or it can simply involve participation in coordination meetings during flood emergencies.

Operation and Maintenance

Flood Operations Center, 2006

Operation and maintenance (O&M) is a crucial component of flood management. For Federally funded projects, the definition of O&M includes the local entity's financial obligation for operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) of the implemented project. OMRR&R is a non-Federal responsibility when local, regional, and/or State entities partner on a Federal project. References to O&M provided in this report include OMRR&R responsibilities when the project is a Federal/non-Federal partnership. O&M activities can include inspection, vegetation management, sediment removal, management of encroachments and penetrations, repair or rehabilitation of structures, or erosion repairs. Because significant flood infrastructure constructed in the early to mid-twentieth century are near or have exceeded the end of their expected service lives, adequate maintenance is critical for this flood infrastructure to continue functioning properly.

4.2.3 Flood Emergency Management

Flood emergency management includes the following preparedness, response, and recovery activities:

- **Flood Preparedness** – Flood preparedness consists of the development of plans and procedures on how to respond to a flood in advance of a flood emergency, including preparing emergency response plans, training local response personnel, designating evacuation procedures, conducting exercises to assess readiness, and developing emergency response agreements that address issues of liability and responsibility.
- **Emergency Response –** Emergency response is the aggregate of all those actions taken by responsible parties at the time of a flood emergency. Early warning of flood events through flood forecasting allows timely notification of responsible authorities so that plans for evacuation of people and property can be implemented. Emergency response includes flood fighting, emergency evacuation, and sheltering. Response begins with, and might be confined to, affected local agencies or operational areas (counties). Depending upon the intensity of the event and the resources of the responders, response from regional, State, and Federal agencies might be required.

Flood Fighting, 2006

- **Post-Flood Recovery** – Recovery programs and actions include restoring utility services and public facilities, repairing flood facilities, draining flooded areas, removing debris, and assisting individuals, businesses, and communities to protect lives and property. Recovery planning could include development of long-term floodplain reconstruction strategies to determine if reconstruction would be allowed in flood-prone areas, or if any existing structures could be removed feasibly. Such planning should review what building standards would be required, how the permit process for planned reconstruction could be improved, funding sources to remove existing structures, natural habitat restoration, and how natural floodplains and ecosystem functions could be incorporated.

4.2.4 Cross-cutting Approaches

Several management actions within Flood Management are considered to be cross-cutting (i.e., they would be a part of all management actions). These cross-cutting actions are permitting, policy and regulations, and finance and revenue.

Permitting

Regional and programmatic permitting methods can provide faster and better delivery of flood management activities, including O&M, repair, habitat enhancement and restoration, and minor infrastructure improvement or construction projects. Regional and programmatic permitting methods can be used

to collectively manage permitting needs for multiple projects, over longer planning horizons, while consolidating mitigation and conservation efforts into larger, more viable conservation areas. This can accelerate permitting of flood system projects and lower per-unit costs versus project-by-project mitigation. Regional and programmatic permitting methods include regional Habitat Conservation Plans, Natural Community Conservation Plans, programmatic Endangered Species Act Section 7 consultations, and Regional General Permits.

Policy and Regulations

Policies and regulations that clarify flood management roles and responsibilities for local, regional, State, and Federal agencies can help improve coordination across the large number of agencies and entities involved in Flood Management. Multiple jurisdictional and regional partnerships can be encouraged for flood planning and flood management activities, including permitting, financing, O&M, repair, and restoration.

Finance and Revenue

Several finance and revenue strategies can increase the ability to fund flood management projects. Aligning flood management projects with other existing or planned projects (such as roads or highways) leverages funding from different agencies and jurisdictions to help accomplish objectives. Consolidating projects on a regional or watershed level can also improve cost effectiveness and financial feasibility by pooling resources.

Agency Coordination on Jones Tract Flood Fight, 2004

5.0 Benefits of an IWM Approach to Flood Management

DWR and USACE are committed to the IWM approach and have started to implement flood management programs to support multibenefit projects. As stated earlier, an IWM approach combines flood management, water supply, and ecosystem actions to deliver multiple benefits. It relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental sciences, public policy, and public information. Successful implementation of an IWM approach requires agencies at all levels to work together to deliver projects that improve public safety, foster environmental stewardship, and support economic stability. Three benefits of implementing an IWM approach include identification of high-value multibenefit projects, regional collaboration and cooperation among agencies, and funding from a range of sources.

5.1 High-Value Multibenefit Projects

The value of using an IWM approach is in the results—improved public safety, enhanced environmental stewardship, and statewide economic stability. Localized, narrowly focused projects are not the best use of public resources and might have negative unintended consequences in nearby regions. The IWM approach can help deliver more benefits at a faster pace using fewer resources than what is possible from single-benefit projects. Examples of high-value multibenefit projects include the Salt River Ecosystem Restoration Project and the San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4, and 5 (see Case Studies 4 and 5).

Case Study 4

Project Name: Salt River Ecosystem Restoration Project

Project Description

The Salt River estuary is part of the Humboldt Bay/Eel River estuary complex encompassing three critical habitats: salmon and steelhead, shorebird wintering and migration, and riparian birds. The project is focused on:

- Restoring the Salt River channel and riparian floodplain to optimize fish passage, riparian habitat, and sediment transport
- Restoring tidal wetland and upland areas near confluence of the Salt and Eel rivers
- Reducing upslope sediment and control erosion in the sub-watersheds

This project is using an adaptive management plan to maintain overall project performance.

North Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: The benefits of this project include:

- Reconnecting Eel River estuary with the Salt River channel and upslope watersheds
- Restoring 7.7 miles of riparian corridor and 444 acres of tidal wetland habitat
- Reducing chronic flooding
- Improving water quality and providing carbon sequestration

Success Factors: Multiple benefits, permitting approach, agency alignment.

Salt River Flooding near Ferndale (Photograph courtesy of Ken Mierzwa, 2004)

Project Status

The project has approximately $15.7 million (current and pending) in funding and is proceeding in two major phases. Phase 1 consists of wetland and upland restoration, as well as excavation and reconfiguration of 1.5 miles of Salt River channel. Phase 2 consists of an additional 5.5 miles of channel excavation and reconfiguration.

Case Study 5

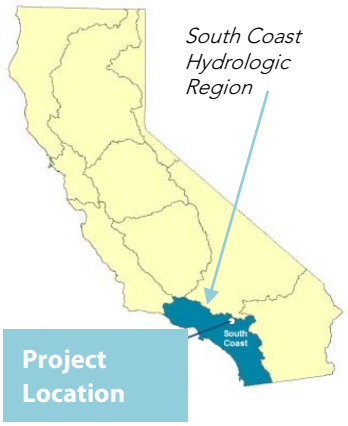
Project Name

San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4, and 5

Description

The project is situated in a developed, highly urbanized area in the north-central portion of the City of Rialto. The project site is an undeveloped field of approximately 140 acres that would be used to capture floodwater for water supply via groundwater recharge. This project has the following components:

- New storage or updating, modifying, or replacing existing flood storage facilities to increase on-stream flood storage capacity.
- Reducing flow constrictions to improve conveyance.
- Providing groundwater recharge to improve water supply at flood basins.
- Improving the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.



Multiple Benefits and Success Factors

Benefits: Benefits include the following:

- Reduced risk of flooding in and around the Rialto Channel by addressing flow constrictions
- Increased groundwater recharge
- Improved quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitats

Success Factors: Flood risk reduction, habitat restoration.

Project Status

In 2011, technical studies were performed related to this project and downstream Rialto Channel. The project was awarded $1,000,000 in Proposition 84 Stormwater Grant funds from DWR through the Santa Ana Watershed Project Authority. Total project costs are estimated to be $31.6 million.

Cactus Basins, San Bernardino (CH2M HILL, 2012)

5.2 Large Range of Solutions

An IWM approach relies on bundling solutions from a variety of disciplines including engineering, economics, environmental science, public policy, and public outreach. These disciplines bring different perspectives in creative problem solving to bear, widening the potential alternative solutions for a project. This allows the different management actions discussed in Section 4 to be bundled together based on regional or project-specific needs. These new project aspects can bring resource agencies and other stakeholders to the table earlier in the planning process, potentially leading to an improved regulatory process with removal of obstacles. Broader solutions can lead to a wider range of funding sources, as described in Section 5.5.

5.3 Regional Collaboration and Cooperation

A benefit of regional collaboration and cooperation is it allows Californians to think holistically to develop long-term integrated approaches to flood management. Using an IWM approach is a process which allows stakeholders to develop long-term working partnerships. Efforts to reduce flood risk and create sustainable, affordable water resources systems will require long-term commitments, alignment, and cooperation among public agencies, tribal entities, landowners, interest-based groups, and other stakeholders. Collaboration must address diverse needs and information gathering, and must deploy other tools, policies, planning, regulations, and investments. The Lower Carmel River Floodplain Protection and Enhancement Project (Case Study 6) and the Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Case Study 7) are examples of successful projects developed through agency collaboration and cooperation.

Case Study 6

Project Name: Lower Carmel River Floodplain Restoration and Flood Control Project

Project Description:

The Carmel River Project is within the lower reaches of the Carmel River watershed. The project area is located at a dynamic interface between marine and freshwater systems and serves as a refuge for sensitive species. The agencies involved in this project are the Big Sur Land Trust, Monterey County Water Resources Agency, Monterey County Public Works Department, and California State Parks. The project was developed to:

- Improve hydrologic functions by reconnecting floodplains through levee setback or removal and land restoration
- Integrate storage and filtration basins into restored floodplains to increase flood flow retention, promote sediment and nutrient removal, and increase groundwater recharge
- Conduct geotechnical engineering analysis and hydraulic modeling needed to support design of flood control improvements
- Modify placement and/or size of existing levees and/or floodwalls, add new levees or floodwalls, construct new bypasses, and restore channel form and function to improve flood protection
- Develop local flood management plan updates
- Establish and preserve agricultural operations adjacent to, but hydrologically disconnected from, the floodplains

Central Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Project benefits include:

- Reduced damages to residences, commercial businesses, and local and State of California infrastructure
- Improved connectivity between the main channel and overbank areas to reduce flooding hazards
- Installation of a protective buffer against sea level changes.
- Restored riparian and wetland habitat within the historical floodplain.

Success Factors: Agency coordination and collaboration

Project Status

Currently, Big Sur Land Trust has secured approximately $17 million in grant funding necessary for project implementation. The California State Parks implemented the Carmel River Lagoon Enhancement Project, and the California State Coastal Conservancy funded $4 million to the California State Parks to lead this effort. Monterey County Water Resources Agency received $500,000 from the U.S. Environmental Protection Agency.

Highway 1 Bridge over the Carmel River during the March 1995 Flood

Source: Monterey Peninsula Water Management District

Case Study 7

Project Name: Middle Creek Flood Damage Reduction and Ecosystem Restoration Project

Project Description:

The Middle Creek Restoration Project is located at the north end of Clear Lake. Major issues in the area over the last 20 to 30 years include flooding and degradation of water quality and habitat. Agencies involved in this project include the Lake County Watershed Protection District, USACE, Central Valley Flood Protection Board, DWR, CDFW, Central Valley Regional Water Quality Control Board, California Bay-Delta Authority, as well as local tribes and other stakeholder groups.

The project consists of:

- Acquiring properties and removing structures within the 100-year floodplain to reduce damage and remove barriers to flow
- Breaching levees to return the natural hydrology to the area
- Improving slope protection, including rock and natural vegetation, to minimize erosion
- Replanting native wetland, riparian, and woody vegetation to stabilize slopes and provide habitat
- Creating channels, sloughs, and ponds similar to those that existed prior to 1920

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits: The benefits of the project include:

- Reducing flood risk by removing structures and property at risk of severe flooding
- Removing approximately 3 miles of substandard levees, as well as one pumping station and one weir structure associated with these existing facilities
- Protecting more than 3 miles of public roads and a major high-voltage electric transmission line
- Improving water quality

Success Factors: Multiple watershed-wide benefits, agency collaboration.

View Looking Downstream Rodman Slough. Photographer standing on the substandard levee proposed to be breached.

Project Status

Construction of the Middle Creek Restoration Project was planned for 2012 through 2015 but has been delayed. The most recent project costs are estimated by the USACE at $48 million (2006 pricing).

5.4 Regional and Systemwide Approach

The benefit of using a regional and systemwide approach is that it takes into account a wide range of causes and effects, reducing potential negative unintended consequences in nearby regions. Regional approaches allow for the best use of public resources by increasing the number of issues considered. This also promotes system flexibility and resiliency by developing solutions that provide the best benefit to the overall system or region. In contrast, localized and narrowly focused projects may solve an issue or problem while transferring the problem up or downstream.

5.5 Access to Multiple Funding Sources

One of the benefits of using an IWM approach is the potential to access funding sources that might not have been available to single-benefit projects. This can lead to achieving sufficient and stable funding for long-term flood management. An example of securing funding from diverse sources is the Flood Management, Habitat Restoration, and Recharge on the San Diego River Project (Case Study 8). Phase II of the project was made possible by working with the California Department of Transportation (Caltrans) to perform crucial elements of the project that benefited all project partners. Another example, the Red Clover Creek Restoration Project (Case Study 9), consists of a group of projects that have been funded through a variety of sources, including local (agencies, landowners, and stakeholder groups), State (bond funding), and Federal (USACE, U.S. Forest Service, and National Resource Conservation Service) sources.

Case Study 8

Project Name: Flood Management, Habitat Restoration and Recharge on the San Diego River

Project Description:

The project is located in the community of Lakeside in San Diego County and is within a 580-acre area known as the Upper San Diego River Improvement Project. Improvements to the San Diego River and adjacent lands are focused on flood management, environmental habitat restoration, recreation, and water supply.

This project consists of project components that:

- Improve flood management and water quality as a result of restoration efforts designed to increase the wetlands, improve circulation in the pond, and improve sediment transport
- Acquire ownership or land tenure on property for preservation or restoration purposes
- Restore riparian habitat types for several threatened and endangered species
- Restore the channel, including work to improve flood management, restore natural meanders, and lower the 100-year flood level by widening the floodway
- Implement low-impact development techniques, including the use of bioswales to capture and treat urban runoff and improve water quality
- Capture flood flows for habitat (wetland) enhancement and for groundwater recharge

South Coast Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Benefits of the project include:

- Reduced flood levels
- Prevention of urban development in a floodplain, currently subject to development pressure
- Improved sediment balance
- Protection of downstream bridges and water pipeline
- Improved water quality via constructed wetlands to treat urban runoff
- Increased water supply through groundwater recharge of the aquifer
- Increased recreation and public access opportunities, including camping areas, trails, and a boardwalk in the pond with access for the disabled

Success Factors: Tenacity for the project, collaborative project partners, phased approach, regional compatibility.

Pre-project Development Sediment Flows

Source: Lakeside's River Conservation District. Photograph courtesy of Peter Nelson.

Project Status

The project was initiated in 2004 and completed in 2010. Lakeside's River Park Conservancy received funding from various sources for the project, which totaled approximately $20.5 million in funding.

Case Study 9

Project Name: Red Clover Creek Restoration Project

Project Description:

The upper Feather River watershed straddles the northern Sierra Nevada Range between the Great Basin Desert and the Central Valley of California. Water originating from its drainages represents a significant component of the State Water Project and provides high-quality water for hydropower generation, agriculture, industry, and cities. Historical mining activities have created sediment issues in the region. The multi-year, large public-private partnership project consists of integrated management actions to:

- Stabilize stream channels to address erosion and improve water quality
- Increase summer base flows for priority species and beneficial uses
- Restore floodplain habitat for sensitive species

Agencies participating or providing funding to this project include a consortium of 24 public and private sector groups.

Sacramento River Hydrologic Region

Multiple Benefits and Success Factors

Benefits: Benefits from this project include:

- Improved stream conditions
- Reduced sediment loads
- Restored floodplain function and habitat, waterfowl and wetland enhancement
- Improved water quality and reduced turbidity
- Reduced impacts to downstream water supply users and flood risk reduction to downstream communities

Success Factors: Broad Funding Sources; Stakeholder collaboration, adaptive management.

Project Status

The project is in development and construction, with funding for individual stages coming from different public and private sources.

Red Clover Creek – Before Restoration

Red Clover Creek – Restored

Source: Red Clover/McReynolds Creek Restoration Project

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6.0 Currently Planned IWM Projects

A number of agencies throughout California are successfully implementing the IWM approach and using a variety of management actions to address different types of flood hazards. Flood management agencies throughout the state have cumulatively invested more than $11 billion in flood management in the last decade, including financing from California's Proposition 1E and 84 bond funds. Although IWM projects are among this investment, increased project incentives, as well as technical assistance, are required to expand the number of these projects.

As part of the information gathering effort, more than 140 local agencies were contacted to assist the SFMP team in identifying both planned flood management and IWM projects in California. To distinguish IWM projects from projects for flood management only, flood management projects that sought to integrate other benefits (e.g., ecosystem restoration, water supply, groundwater recharge, recreation, hydropower) were identified as IWM projects.

Furthermore, the most recent plans from each of the 48 IRWM regions were collected and reviewed for additional IWM project information. Each of the IRWM regions was contacted to verify the information compiled. More projects can be added to the list in the future when new projects are identified during development or update of their IRWM plans.

More than 900 projects and improvements totaling more than $50 billion in planned projects were identified from local agencies in all regions, including State efforts such as the CVFPP and Sacramento – San Joaquin River Delta (Delta) improvements, and Federal agencies (USACE). However, this does not represent the total cost of the planned projects because approximately 20 percent of the projects listed do not have associated cost estimates at this time. Section 6 outlines the specific IWM cost information available for each source of proposed/planned projects. For CVFPP and Delta improvements, specific project information was not available so total IWM project cost estimates represent local and USACE planned/proposed projects. Section 6 provides a breakdown of the number and costs associated with planned projects using an IWM approach.

6.1 Local Planned Projects

As shown in Table H-1, 287 locally planned flood management projects statewide use an IWM approach. Information for these planned projects is presented in Appendix C.

Table H-1. Summary of Local Planned Flood-Related IWM Projects

Hydrologic Region	Total Number of Local Planned Projects	Number of IWM Projects	Number of IWM Projects with Cost	Number of IWM Projects without Cost	Total Value of IWM Projects with Cost ($ million)
Central Coast	42	29	19	10	110
Colorado River	24	1	1	0	2
North Coast	26	15	11	4	100
North Lahontan	13	5	4	1	20
Sacramento River	160	67	36	31	240
San Francisco Bay	118	43	32	11	950
San Joaquin River	55	25	19	6	580
South Coast	335	63	56	7	1,030
South Lahontan	33	21	19	2	130
Tulare Lake	30	18	18	0	220
Total	**836**	**287**	**215**	**72**	**3,382**

Note: All projects were identified as of January 2012.

6.2 Central Valley Flood Protection Plan

The CVFPP has identified additional flood improvements as part of its State Systemwide Investment Approach (SSIA) that would include additional projects with an IWM approach. The SSIA is the State's preferred approach for modernizing the State Plan of Flood Control (SPFC) to address current challenges to achieve the CVFPP goals of improving flood management, improving O&M, promoting ecosystem functions, improving institutional support, and promoting multibenefit projects.

Future project needs of $14 to $17 billion have been identified in the CVFPP. These projects represent the proposed improvements to SPFC facilities and complementary actions for flood management in the areas protected by the SPFC. It does not include all remedies for the complete list of flood infrastructure needs.

Table H-2 presents a summary of the potential for incorporating an IWM approach for each element and provides a preliminary cost estimate for the SSIA. All costs are planning-level estimates; they are based on 2011 price levels and will differ in the future. Actual costs will vary from those in Table H-2 because of a wide range of factors, including project justification by feasibility studies, project configuration, implementation time, future economic and contractor bidding conditions, as well as a number of other factors.

Table H-2. Estimated Costs of SSIA Proposed Projects in CVFPP and Projects with Potential for an IWM Approach

Element	Potential for IWM Approach	Estimated Costs ($ million)
Urban Improvements	Low	5,500 to 6,670
Small Community Improvements	Medium	690 (approximately)
Rural-Agricultural Improvements	High	1,080 to 1,190
System Improvements	High	5,150 to 6,500
Residual Risk Management	Low-None	1,520 to 1,870
Total Cost		**$13,940 to 16,920**

Notes:

The cost estimates include SPFC flood management investments that have already been expended or committed during 2007 to 2011.

Some elements of locally identified projects included in the IWM Project List might be included in the CVFPP overall cost estimates.

All costs are planning-level estimates are based on 2011 price levels and will differ in the future. Actual costs will vary because of a wide range of factors, including project justification by feasibility studies, project configuration, implementation time, future economic and contractor bidding conditions, and many others.

Source: DWR, 2012

6.3 Delta Improvements

Currently, no comprehensive flood risk reduction plan exists for the Delta, and no associated cost estimates are available. Costs for future levee improvements will depend on what level of protection is shown to be cost effective for individual islands/tracts and for the network of islands/tracts. Levees for individual islands/tracts not only provide direct benefit to the areas they protect but also provide benefit as part of the network of levees that define the water channels and the configuration of the Delta. As a result, the level of protection provided by levees will vary. Due to the complex nature of the Delta and the number of agencies and stakeholders involved, most Delta improvements will likely be developed using an IWM approach.

Ongoing programs and investigations will influence future plans for the Delta, but no current cost estimates are available from these efforts as yet. Therefore, past studies were used to show a range of potential costs to improve Delta levees to achieve different levels of flood protection. The past study estimates show a wide range of potential improvements, with estimated costs ranging from $0.1 billion to over $17 billion. The wide range in cost estimates is due to variability in existing reports and available information. With the lower estimate that accepts more levee failures, responsible agencies will need to place more effort on future recovery from flooded islands/tracts, or make decisions not to recover certain areas after flooding. Costs for Delta improvements also will vary based upon the number of projects developed using an IWM approach.

6.4 USACE Planned Projects

For the 2012 fiscal year, 33 USACE-proposed flood management projects using an IWM approach were identified in California, with an aggregate total of approximately $2 billion. These projects comprise new and ongoing flood risk studies and authorized construction projects. Of these 33 projects, 9 projects were funded for fiscal year 2012. Table H-3 presents a summary of the planned USACE projects using IWM approaches, categorized by hydrologic region. The costs listed in Table H-3 include local and Federal costs for the full project. Projects from other programs, including the Flood Plain Management Services and the Planning Assistance to States, are not captured here. Such projects are USACE recommendations for funding appropriations in California to be included in the President's budget; however, this recommendation does not imply that any project will receive appropriations. Each funding request may or may not be included in the Energy and Water Appropriations for any given year.

Thirty-three of the 60 identified USACE proposed projects use an IWM approach, with an estimated total cost of $4.8 billion. This illustrates progression toward integrated approaches to flood management practices. A complete list of USACE potential and ongoing flood projects identified as using an IWM approach is included in Appendix D.

Table H-3. Summary of USACE Planned Flood-Related IWM Projects

Hydrologic Region	Number of IWM Projects	USACE Project Cost Share for IWM Projects (millions)	Number of Projects Funded in FY 2012	Funding Appropriated in FY 2012 (millions)
Central Coast	2	310	0	-
Colorado River	0	-	0	-
North Coast	2	150	0	-
North Lahontan	0	20	0	-
Sacramento River	2	230	0	-
San Francisco Bay	10	450	4	3
San Joaquin River	0	10	0	-
South Coast	13	420	4	29
Tulare Lake	4	500	1	13
TOTAL	33	$2,090	9	$45

FY Fiscal Year
Source: USACE, 2012b and USACE, 2013

6.5 Statewide IWM Projects

Statewide, there were 320 planned/proposed projects identified as using an IWM approach to the practice of flood management. This number reflects local and USACE projects only because no specific projects have been identified for CVFPP and Delta improvements (as described above). As shown in Table H-4, projects using an IWM approach account for over 35 percent of the total number of identified planned/proposed projects. Table H-4 also presents a summary of the

estimated costs of the planned local and USACE projects using IWM approaches categorized by hydrologic region. Although not all projects have cost estimates, the list of projects illustrates the wide variety of flood projects using an IWM approach undertaken by agencies in each hydrologic region.

Projects using an IWM approach that have a flood management component are most commonly combined with ecosystem restoration (approximately half of the projects using an IWM approach) or water supply components (as addressed by about a quarter of the projects). The Sacramento River and South Coast hydrologic regions have the most proposed/planned projects that use an IWM approach.

Figure H-1 presents a summary of the number of planned projects, both local and USACE, using an IWM approach in each hydrologic region of California. Most of these projects are planned in the urban areas of the state, such as in the counties of Los Angeles, Orange, Santa Clara, and San Diego.

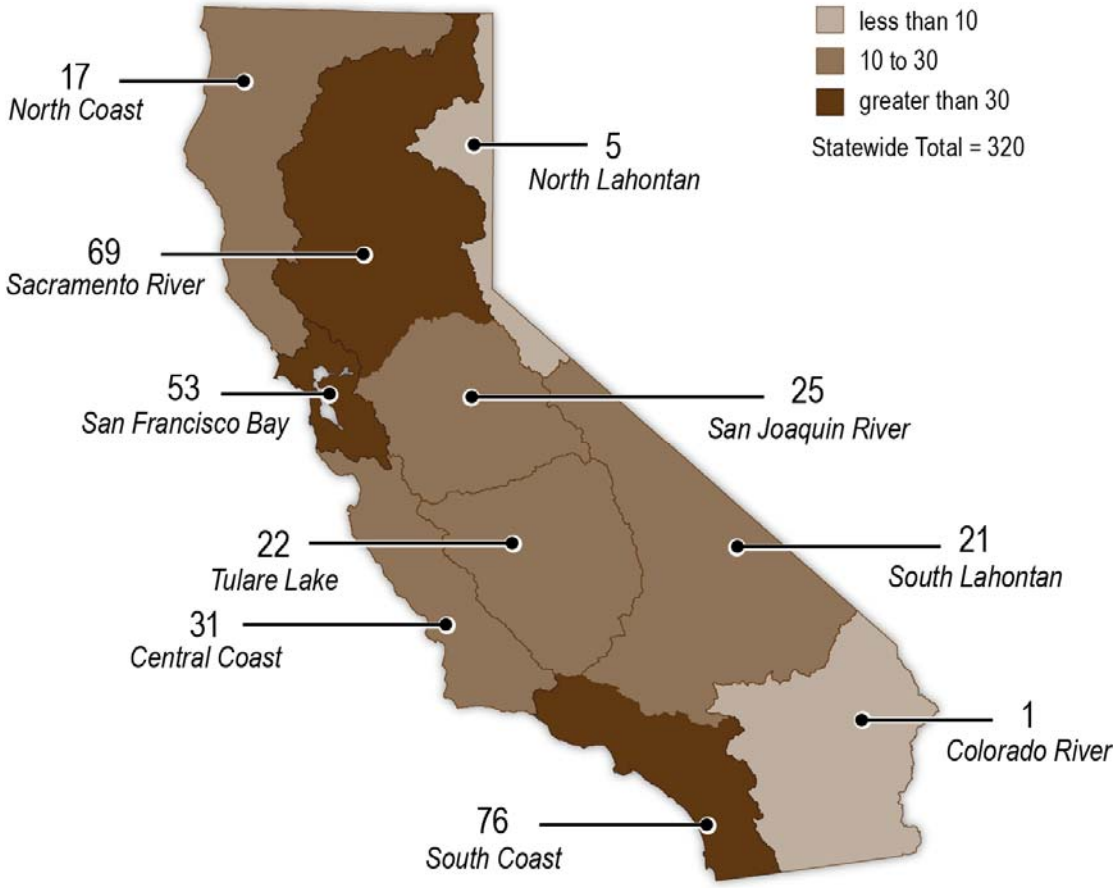

Figure H-1. Map of Local and USACE Planned Flood Management Projects Using an IWM Approach

Table H-4. Summary of Local and USACE Planned/Ongoing Flood-Related IWM Projects

Hydrologic Region	Total Estimated Cost of Projects ($ million)	Total Estimated Cost of IWM Projects ($ million)	Total Number of Projects (Local and USACE)	Total Number of IWM Projects	Flood-Related IWM Project Type					
					Agriculture	Ecosystem	Water Supply	Recreation	Water Quality	Transportation
Central Coast	780	420	48	31	1	15	2	1	11	1
Colorado River	70	2	25	1	0	0	1	0	0	0
North Coast	260	250	28	17	1	6	4	1	4	1
North Lahontan	40	40	14	5	0	3	1	1	0	0
Sacramento River	2,550	470	163	69	1	40	14	3	9	2
San Francisco Bay	3,370	1,400	135	53	0	40	2	5	4	2
San Joaquin River	780	590	59	25	0	10	13	0	2	0
South Coast	8,400	1,450	354	76	0	35	18	5	14	4
South Lahontan	170	130	33	21	0	6	10	2	3	0
Tulare Lake	1,270	720	37	22	1	7	11	1	2	0
SUMMARY	17,690	5,472	896	320	4	162	76	19	49	10
Percent of Total	N/A	N/A	N/A	N/A	1%	51%	24%	6%	15%	3%

Note: All IWM projects listed in this table include a flood management component in addition to other components explicitly identified here. All projects were identified as of January 2012.

Source: USACE, 2012b and USACE, 2013

7.0 Findings and Recommended Actions

7.1 Findings on the IWM Approach

Flood management practices have evolved from single-purpose projects to a more holistic IWM approach. A number of challenges and opportunities exist for project implementation using an IWM approach (as shown in Table H-5), most significantly with agency alignment and cooperation, as well as with competing needs and objectives between agencies. Using an IWM approach provides significant benefits, including high-value multibenefit projects with broader access to funding. Other key findings on the IWM approach include the following:

- The current economic and ecosystem conditions make it more important than ever for all public agencies to use an IWM approach for near-term and long-term planning.
- An IWM approach that combines flood management, water supply, and ecosystem actions to deliver multiple benefits is the best use of public resources.
- IWM is complex and requires long-term commitments among the responsible public agencies to align their sometimes conflicting missions and objectives.
- Involvement of a broad spectrum of agencies and stakeholders in project development builds advocacy and support for multibenefit programs and projects, addresses institutional conflicts, and helps expand the range and diversity of funding sources.
- Collaboration and alignment among diverse agencies and stakeholders is the single most-cited success factor in the case studies illustrated in this document.

Table H-5. Challenges and Opportunities to Implementing an IWM Approach

Types of Implementation Hurdles	Challenges	Opportunities
Increased Coordination	An IWM approach requires involving a large number of agencies with complex jurisdictional roles and responsibilities, and multiple management goals. Coordinating activities across geographic and agency boundaries from a system perspective can require large investments of time and funds, which can be particularly difficult for smaller local agencies. The sheer number and types of agencies can also create difficulties in establishing a collaborative approach or even in determining who should be involved in IRWM and IWM projects. Some stakeholders might object to a portion of a project for which the flood agency does not have a direct interest, thereby complicating IWM implementation.	Coordination among diverse agencies and entities can be effective in addressing the multitude of jurisdictional and facility ownership issues and restrictions commonly encountered in complex flood and water management projects. Coordination can address potential areas of conflict in project goals before they occur and reduce unintended consequences. Similarly, multipurpose projects are more likely to engage stakeholders that a flood agency does not typically work with. By engaging stakeholders and participation from a system perspective, the opportunity to build advocacy, accelerate project implementation, and become aware of potential pitfalls before they occur are greatly improved.

Table H-5. Challenges and Opportunities to Implementing an IWM Approach

Types of Implementation Hurdles	Challenges	Opportunities
Competing Land Uses on Floodplains	Many floodplains are already urbanized or have other competing land uses, restricting opportunities for IWM approaches to projects. The public is often unaware of their flood risk or the beneficial functions of floodplains.	Floodplains can provide excellent land for agriculture, groundwater recharge, and desirable access to water and recreation. Education of the public and decision makers about the land-water interaction can yield positive results for all elements of water management.
Long-Term Planning Horizons	An IWM approach requires long-term planning and investment, which are difficult to promote when the public is often focused on short-term issues.	Long-term approaches are often more likely to yield sustainable results, which ultimately are better investments.
Funding	Some funding sources have strict requirements that tie funding to specific, authorized program purposes. These restrictions, while important for accountability, can inhibit funding opportunities for multibenefit projects.	IWM solutions promote projects with multiple objectives and increase access to more funding sources. Several State and Federal agencies (such as USACE and DWR) promote the IWM approach and have structured their flood management programs to support multibenefit IWM-approach projects. Coordination across geographic and agency boundaries can help multiple agencies pool and leverage their funding to achieve multiple objectives. A multipurpose IWM project approach can often achieve benefits with less cost and a smaller footprint than multiple single-purpose projects.
Regulation, Permitting, and O&M	Projects with an IWM approach often must comply with increased permitting and regulatory requirements because of the multiple purposes they serve. This typically increases project complexity and planning costs.	Environmental enhancements designed to accommodate routine O&M can help reduce mitigation requirements and reduce long-term O&M costs. In some locations, permitting agencies have started to collaborate through regional permitting to find ways to streamline permitting that balances competing needs.
Climate Change	Climate change might lead to sea level rise and alter precipitation and runoff patterns, creating uncertainty for several resource management areas related to projects using an IWM approach.	Because IWM project approaches are more integrated with natural systems, these projects offer more options to address the uncertainty presented by climate change and other variables. The flexibility of using an IWM approach lends itself well to adaptive management.

7.2 Recommended Actions

Based on the findings, the following actions are recommended to bolster the IWM approach statewide while developing flood management solutions:

- Improve sharing of data and other information between public agencies to foster collaboration and cooperation between agencies.
- Facilitate regular coordination between land use planners, resource managers, and floodplain managers to improve working relationships and protect public safety.
- Link funding for flood management and other project types to the use of practices that support an IWM approach to land and to project development.
- Implement flood management from regional, systemwide, and statewide perspectives to provide multiple benefits by:
  - Creating Regional Flood Planning Areas that address region specific flood management issues, opportunities, and solutions
  - Developing a bottom–up approach for prioritizing flood projects that value multiple benefits
  - Improving consistency of terminology related to IWM approaches and projects, and consistency of processes for funding and securing project support from State and Federal agencies
  - Incentivizing an IWM approach by linking funding requirements to using an IWM approach
- Increase collaboration among public agencies to improve flood management planning, policies, and investments, which will increase effectiveness of flood management by:
  - Utilizing existing planning groups and other forums to improve coordination of water management for multi-objective projects
  - Facilitating programmatic permitting for multiple projects over longer planning horizons by showing a full range of project benefits to regulatory agencies
  - Fostering interagency coordination and collaboration in planning, project development, and emergency management by providing in-kind credits and other funding linked to using an IWM approach
  - Establishing consistent methods to evaluate project priorities statewide based on an IWM approach

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8.0 References

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Appendix A: Flood Future Report Components

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Appendix A: Flood Future Report Components

California's Flood Future Report is composed of three layers of documents, which were developed with different audiences and purposes, as shown in Figure H-A-1. The three main layers are the Policy Brief, Highlights, and main report including the technical attachments (or technical memoranda).

The Policy Brief document provides a high-level summary of the key information contained in the Flood Future Report and its technical attachments. This document is meant to inform legislators, legislative staff, and agency executives about the report.

The Highlights document, which is an Executive Summary of the Flood Future Report, is more detailed than the Policy Brief slightly expanding the level of detail of the information provided in the Policy Brief. The Highlights document is intended for use by legislators, legislative staff, agency executives, and the public.

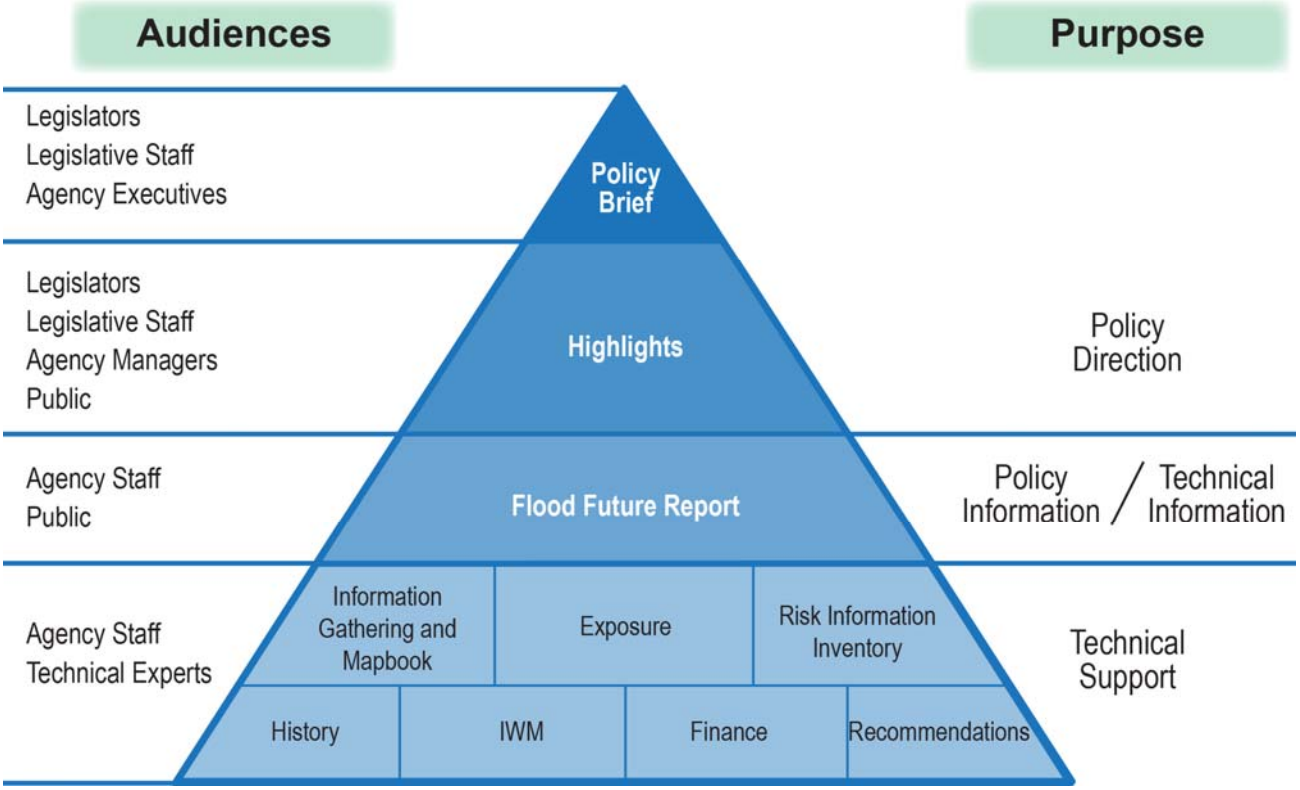

Figure H-A-1. Flood Future Report Components Diagram

The Flood Future Report provides a compilation of the information developed in the technical attachments. This document contains a comprehensive look at flooding throughout the state, and it describes the challenges and opportunities facing flood management. The Flood Future Report also provides information to make decisions about policies and financial investments to improve public safety, environmental stewardship, and economic stability.

This report is supported by eight technical attachments:

- ***Attachment A: References***
- ***Attachment B: Glossary***
- ***Attachment C: History of California Flooding.*** This attachment provides a detailed history of flooding in the 10 major California Water Plan hydrologic regions.
- ***Attachment D: Summary of Exposure and Infrastructure Inventory by County (Mapbook).*** This attachment is a mapbook organized by county providing information on exposure to flooding, flood infrastructure, flood types present, list of major floods, and information on the planned/proposed projects.
- ***Attachment E: Existing Conditions of Flood Management in California (Information Gathering Findings).*** This attachment provides an overview of the information gathering effort to collect flood management information from local, State, Tribal, and Federal agencies, as well as a detailed summary of the results of the information gathering effort. The purpose of this effort was to develop a better understanding of flood risk management in the State of California.
- ***Attachment F: Flood Hazard Exposure Analysis.*** This attachment describes the methodology used to identify flood hazard exposure statewide as well as the results of the flood hazard exposure analysis. This analysis was performed to provide insight into potential flood risks throughout the state.
- ***Attachment G: Risk Information Inventory.*** This attachment provides a better understanding of flood risk statewide, based on the best available information. To characterize flood risk in the California, the SFMP developed a risk exposure analysis used in conjunction with an inventory of risk-relevant information gathered from agency meetings.
- ***Attachment H: Practicing Flood Management Using an Integrated Water Management Approach***. This attachment provides a description of the evolution of flood management practices toward and using an IWM approach, an overview of IWM, the benefits of using an IWM approach, and sample case studies of projects that have used an IWM approach.
- ***Attachment I: Finance Strategies.*** This attachment provides an understanding of the current status of flood management financing and the challenges that lie ahead as California develops recommendations to address flood management issues.
- ***Attachment J: Recommendations to Improve Flood Management in California.*** This attachment provides a detailed description of how the Flood Future Report recommendations were developed and outlines the recommendations along with other high-level challenges.

Each of the documents follows a color scheme that was developed for the Highlights document. The documents are formatted using different-colored headers to indicate the purpose of a given section. The color scheme follows the following coding format:

- Introduction (light blue)
- Understanding the Situation (brown)
- The Problem (goldenrod)
- The Solution (royal blue)
- Recommendations (green)
- The Path Forward (yellow)

Any and all appendices to an attachment were coded using a light blue to represent that this is background or supporting information.

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Appendix B: Management Action Descriptions

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Appendix B: Management Action Descriptions

Management actions were initially developed from the 93 management actions included in the Central Valley Flood Management Planning Program (CVFMP) *Management Actions Report* (DWR, 2010). Since the CVFMP was specific to flooding in the Central Valley, these management actions were revised and consolidated, and additional ones were identified to address other types of flooding, such as alluvial fan, coastal, tsunami, local stormwater, and engineered structure failure flooding.

Input from USACE and DWR flood management experts was collected to identify additional management actions. The following references were reviewed:

- USACE Coastal Engineering Manual (EM) 1110-2-1100 (USACE, 2002)
- Final documents from the Alluvial Fan Task Force (AFTF, 2010a and 2010b)
- Local Hazard Mitigation Plans
- DWR Division of Dam Safety references
- Project information collected from the SFMP Information Gathering phase

A total of 103 structural and nonstructural management actions were identified through this process. For each management action, the problem addressed, methodology, and desired outcome were described, as well as the economic, environmental, and social considerations associated with implementation. A management action was then evaluated for the type(s) of flood hazard(s) it could address.

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Table H-B-1. Draft SFMP Management Action Descriptions

Index	Management Action	Problem Addressed	Desired Outcome	Methodology	Economic Considerations	Environmental Considerations	Social Considerations	Flood Hazard Types Addressed							Flood Risk Addressed			Integration Opportunities													
								Slow Rise	Flash	Debris Flow	Alluvial Fan	Coastal	Tsunami	Engineered Structure Failure	Stormwater Management	Hazard	Exposure	Vulnerability	Water Supply	Groundwater Recharge	Water Management Flexibility	Ecosystem Habitat	Invasive Species Management	Restore Natural Floodplain Processes	Erosion/Sediment Management	Fisheries	Recreation or Open Space	Hydropower	Navigation	Water Quality	Improve Agency Coordination
Flood Infrastructure																														
SM-1	Improve conveyance by addressing flow constrictions.	Constrictions and vegetation such as bridges, marinas, in-channel structures, and other obstructions can trap large debris during flood events causing floodwaters to back up. The backwater caused by the constrictions can increase pressure on the levees and increase sediment accumulation upstream of the restriction while incising the channel bed and/or eroding channel banks downstream. Flow constrictions could impact the channel's ability to accommodate reservoir's objective releases.	Increase channel or bypass flood conveyance capacity and efficiency by reducing impedance to flood flow, where feasible.	Removal, modification, or relocation of flow constrictions and hard points can increase overall channel capacity and/or reduce flooding upstream. This could improve operational flexibility of reservoirs. Specific actions or treatments would depend on the type of flow constriction or hard point.	Potentially high initial costs depending on number and type of flow constrictions to be removed, replaced, or modified. Impact on annual operation and maintenance (O&M) costs is variable.	Minor to moderate temporary impacts during construction, and potentially permanent impacts to aquatic and riparian habitats. Could contribute to rehabilitating physical processes and improving fish passage.	Highly dependent on site location and type of flow constriction. Institutional, funding, and public relations challenges exist.	X	X							X			X			X		X	X	X	X		X		
SM-2	Increase capacity of existing bypasses.	Due to changes in the channel morphology, some bypasses cannot convey flood flows at their designed flow rates and corresponding design stage. This lack of conveyance results in higher flood stages in the channel and increase the stresses on the levees; thereby increasing the risks of flooding.	Increase or restore the flood conveyance capacity of existing bypasses.	Could include widening or expanding the footprint of existing bypasses to increase capacity. It could include raising levees or berms along existing bypasses to create more flood-carrying capacity. It may require the reconstruction and/or re-operation of existing flow control weirs that direct flood flows into bypasses. This measure could include sediment removal or vegetation control.	Potentially high initial costs depending on number and type of modifications and real estate needs. Impact on annual O&M costs is variable. Potential for water supply impact if constructions serve as in-stream recharge purposes.	Could enhance key physical processes and ecological functions by restoring more natural flow regime to bypasses within historical overflow areas. Could result in substantial permanent impacts including loss of upland habitat. Could change sedimentation transport. Extensive, complex, and potentially costly permitting required.	Bypass modification likely to be more feasible/implementable than construction of new bypasses. May face opposition from some landowners because it would restrict land use within the bypass. Institutional, funding, and public relations challenges exist.	X	X							X						X		X	X	X	X				
SM-3	Modify existing weirs, overflows, or relief structures to improve flood system performance.	The performance and operation of weirs and flood overflows can be negatively affected by factors such as accumulation of sediment or debris, downstream flow restrictions, antiquated control systems, subsidence, erosion, structural deficiencies, and functional obsolescence. Their design parameters (how the flows are regulated), may be functionally obsolete due to changes in the flood flows caused by differing land use, climate, and weather patterns.	Improve flood system operations and performance by modifying existing weirs and overflows; provide or restore flood conveyance and storage; make water control structures that are robust and flexible to meet current and future flood management needs.	Weirs could be modified in several ways (raised, lowered, lengthened, or automated), changing the weir sill elevation depending upon the operation and desired effect.	Moderate to high initial costs to raise, lower, lengthen, or automate weirs depending on the type, operation, and desired effect. Potential to reduce annual O&M costs. Potential to impact water supply if existing weirs are used for groundwater recharge.	Varies by implementation. Could enhance key physical processes and could moderately alter physical processes downstream. Substantial permitting likely needed.	Institutional and funding challenges exist.	X	X									X	X				X	X	X				

Table H-B-1. Draft SFMP Management Action Descriptions

Index	Management Action	Problem Addressed	Desired Outcome	Methodology	Economic Considerations	Environmental Considerations	Social Considerations	Flood Hazard Types Addressed								Flood Risk Addressed			Integration Opportunities													
								Slow Rise	Flash	Debris Flow	Alluvial Fan	Coastal	Tsunami	Engineered Structure Failure	Stormwater Management	Hazard	Exposure	Vulnerability	Water Supply	Groundwater Recharge	Water Management Flexibility	Ecosystem Habitat	Invasive Species Management	Restore Natural Floodplain Processes	Erosion/Sediment Management	Fisheries	Recreation or Open Space	Hydropower	Navigation	Water Quality	Improve Agency Coordination
SM-4	Construct new bypasses to improve flood system performance.	Some reaches may have insufficient flow capacity or insufficient conveyance due to lack of transitory storage and ability to attenuate the flood flows. Limited funding for structural improvements may require a reevaluation on how the floodwaters are routed through the flood management system.	To provide relief to the areas of the flood conveyance system that do not have the capacity to provide the required level of flood protection by constructing new bypasses to add capacity	New bypasses could be constructed to redirect damaging flood flows away from the existing channels and facilities that currently lack sufficient conveyance.	High initial costs depending on location and extent of real estate and construction needed for bypasses. New annual O&M costs.	Could be designed to enhance key physical processes and ecological functions. Could result in moderate to substantial permanent impacts to terrestrial and agricultural habitats. Extensive and complex permitting.	Feasibility would be highly dependent on location (real estate requirements, land uses or infrastructure affected), cost, and magnitude of benefits provided. Creating a new bypass means relocating people within that area. Political acceptability may be low.	X	X									X	X	X		X		X	X	X	X				
SM-5	Construct new levees or floodwalls to provide flood protection to additional areas potentially affected by flooding.	Due to changes in the land use patterns, channel hydraulics, and environmental conditions, portions of channels without levees may need new levees or floodwalls constructed to meet current level-of-safety requirements.	Construct additional levees or floodwalls as needed to improve public safety and improve the robustness and flexibility of the flood management system.	New levees or floodwalls could be constructed along river reaches where no facilities are currently present to increase the carrying capacity of the existing river channel and modulate peak flows.	High initial costs, dependent on location and amount of new construction of levees or floodwalls. New annual O&M costs.	Substantial permanent impacts to terrestrial, riparian, and shaded riverine aquatic habitats; substantial alteration of physical processes. Extensive and complex permitting.	High capital costs, environmental impacts, and significant land acquisitions may present a challenge to widespread implementation.	X	X			X	X	X				X								X				
SM-6	Raise levees to improve flood system performance.	Levee reaches with insufficient freeboard to meet existing design criteria.	Provide an adequate level of freeboard and increase the conveyance capacity of the channel adjacent to the levee by raising levees so they meet requirements for level of safety.	Levees can be raised by the addition of earthen material or by constructing floodwalls. Raising levees could allow larger design flows, or larger project flows, to pass with adequate freeboard.	High initial cost (unless only a small levee raise). Minimum or no significant increase in annual O&M costs.	Could result in substantial permanent impacts to terrestrial habitat. Could moderately alter physical processes. Extensive and complex permitting.	Real estate acquisitions may be necessary if widening the footprint of an existing levee. Neighborhood and community opposition could be significant.	X	X			X	X	X				X								X				

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SM-7	Construct setback levees.	Some reaches have insufficient conveyance caused by restrictions in the channel and/or environmental considerations that restrict maintenance activities, reduce the natural capacity of floodplains to provide flood storage and conveyance, and can cause sedimentation and scour in unanticipated places due to changes in dynamics of sediment transport.	Construct setback levees where feasible to improve channel conveyance, improve the level of safety, and minimize disruptions to vital riparian corridors.	Expanding channel capacity by setting levees back from the main river could provide a sustainable approach by enhancing flood system performance and reducing levee erosion over the longer-term.	High initial costs for real estate acquisition and new construction. No significant increase in annual O&M cost, with potential for reduced long-term costs.	Could rehabilitate key physical processes by reconnecting channels to historical floodplains and by enhancing sediment transport, channel and floodplain forming processes, groundwater recharge, and improving water quality. Would rehabilitate ecological functions. Would result in moderate to substantial permanent impacts to terrestrial and agricultural habitats. Permitting would be expensive and complex.	High capital costs and land acquisition challenges may present a challenge to widespread implementation.	X	X		X			X		X		X	X	X		X		X	X	X	X				
SM-8	Construct ring levees.	There are small communities and critical infrastructure that are at risk of flooding, either because they have no flood control protection or the existing flood control protection is insufficient and unreliable.	Construct ring levees where feasible to protect critical infrastructures and increase the level of protection for small communities.	Reduction in flood risk to small communities and individual structures can be achieved by constructing ring levees or internal levees. A ring levee is constructed around the protected area, isolating it from potential floodwaters. Internal levees, on the other hand, serve as a second line of defense by compartmentalizing and isolating portions of the protected area.	High initial costs to obtain real estate and construct new ring levee. New annual O&M costs for ring levee and associated infrastructure.	Substantial permanent impacts, including loss of terrestrial and potentially wetland habitat. Extensive and complex permitting required.	Generally politically acceptable. Ingress and egress from ringed areas may become more difficult during flood events. Can also segregate the community, create inequalities and limit economic growth. May promote a false sense of security for communities within ringed areas.	X	X			X	X	X				X								X					

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SM-9	Improve structural performance and resilience of existing flood facilities.	Existing flood facilities in certain areas have deficiencies that increase the risks of failure during a high-water event. Deficiencies include inadequate embankment geometry, seepage, toe erosion, foundational stability, and seismic risks.	Reduce the risk of failure on existing flood facilities.	The integrity of earthen flood facilities can be enhanced by improving embankment soil properties and geometry to resist slope and seepage failures. Improving resistance to slope failure can be achieved by adding material to widen the top width, flatten steep slopes, or both. Methods to address seepage include seepage berms, impermeable barrier curtains (slurry cutoff wall) in the flood facility and/or its foundation, and relief wells and toe drains. Armoring the landside of a flood facility can improve its resiliency during overtopping episodes. Seismic strengthening may be needed for some facilities.	Moderate to high initial costs, depending on the extent and type of modification and real estate needed. No change or slight reduction in annual O&M costs.	If the footprint of the existing flood facilities is expanded, it could result in substantial permanent impacts to terrestrial habitat and could moderately alter physical processes (including sediment transport).	Improving the reliability of flood facilities is politically desirable. However, costs and permitting considerations may present a challenge to widespread implementation. Real estate and right-of-way needs may generate neighborhood or community opposition.	X	X	X	X	X	X	X				X							X						
SM-10	Construct closure structures.	Many levees/floodwalls are interrupted by crossings and other at-grade penetrations that lower the flood control structure elevation. Such crossings include railroad tracks, roads, and highways. Many of these gaps include structures that would be closed during periods of high water to complete the flood control closure and prevent inundation of the protected area. Some gaps do not currently have closure structures, which may reduce the level of protection of the surrounding flood control system and put the protected lands (and lives) at risk.	Gaps in alignments modified to include closure structures where warranted.	All gaps would be identified, and gaps without closure structures would be evaluated to assess whether a structure is warranted. New closure structures (i.e., flood gates) would then be constructed.	Variable initial costs, depending on location, type, and use. Low annual costs associated with operational drills and upgrades to the closure structures.	Potential for adverse environmental impact exists during construction of new structures.	Likely to receive local public support. If a gap is identified in a flood control system, there is likely an impact to level of protection of the surrounding flood control system. Construction of a closure structure would benefit the entire flood control system and lands that are being protected.	X	X			X	X	X				X												

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SM-11	Remove and/or deauthorize disconnected, redundant, obsolete, and nonfunctional facilities	There are currently facilities that are no longer functional, disconnected from the system, and/or redundant; however, maintenance resources continue to be committed to these facilities.	Identify candidate facilities for removal and develop the process for removal and deauthorization of these facilities.	Identify existing facilities that could be strong candidates for removal without causing significant adverse impacts to the respective flood management system or ancillary facilities. This analysis would include the specific candidate facilities identified for potential removal, the reasons for removal, potential impacts or other implications of removal, costs of removal, and additional actions associated and/or required with removal. This would require determining the roles and responsibilities of local, State, and Federal agencies and would possibly require determining the process to deauthorize levees from State or Federal jurisdiction.	Medium to high initial costs. Cost of removing facilities would vary, depending on the type of facility (e.g., a silted-up reservoir vs. an obsolete bypass), decommissioning and disposal requirements, and mitigation requirements. Annual O&M costs would decrease. Potential to impact water supply.	Removal of nonfunctional facilities could rehabilitate key physical processes (e.g., sediment transport balance and meander migration), as well as floodplain- and channel-forming processes. Removal could rehabilitate floodplain riparian habitat and result in moderate to substantial permanent impacts to terrestrial and agricultural habitats, and potentially to canal or seasonal wetland habitats. Permitting would be extensive and complex.	Roles and responsibilities of local, State, and Federal agencies would be impacted by removing and/or deauthorizing facilities. May impact recreational use of the obsolete facility.	X	X	X	X	X	X	X	X			X				X		X	X		X				
SM-12	Construct debris basins	Debris-laden flows can result from alluvial fans. Debris flows can also result from wildfires. Debris-laden flows can destroy structures, wash out roads and bridges, sweep away cars, knock down trees, and lay down several-foot-thick deposits of mud, rock, and other debris where they come to rest, obstructing drainages and roadways.	Reduction in debris-laden flooding.	Construct debris basins in areas downstream of debris-laden flows. Debris basins retain the debris and reduce downstream flooding. A spillway is usually needed to safely release flow in excess of the design storage capacity and downstream channel.	Medium to high initial costs. New annual O&M costs would be needed to clean the debris basins on a regular basis.	Debris basins often require a large footprint and additional infrastructure such as concrete channels that can result in the loss of riparian and wetland habitats.	Institutional, funding, neighborhood, and community opposition challenges exist.			X	X				X			X	X						X				X	

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SM-13	Preserve active washes	Alluvial fan flooding can occur with little warning. In some other instances, the meteorological conditions that may lead to alluvial fan flooding are present or predictable, and there is time to take precautionary measures. Alluvial fan flows can be particularly hazardous because large debris can be transported by the fast-moving, dense, and viscous matrix of slurry and boulders. Traditional approaches to address alluvial fan flooding (e.g., debris basins, concrete channels) have had negative impacts on ecosystem restoration, groundwater recharge, and aesthetic value, and can result in significant long-term O&M costs.	Reduction in alluvial fan flooding while achieving multiple objectives (ecosystem restoration, groundwater recharge, recreation).	A wash isolates active fan areas downstream of the apex of the fan, eliminating the need for a debris basin at the mouth of the canyon and a concrete channel for the outflow. A preserved active wash allows debris from the watershed to deposit before reaching the end of the wash. The wash provides natural indirect recharge. Development is kept outside the wash, away from the area of greatest risk.	Low initial and annual O&M costs relative to the construction and O&M of debris basins and concrete channels.	A wash would support ecosystem functions, including sediment and nutrient transport that sustains riparian habitat for sensitive and endangered species, critical habitat and movement corridors for wildlife and native plants, and open space/recreation value. However, some levees would be required to form a wash, which would have some environmental impacts.	Although an active wash eliminates development in the area, it provides open space, which is often viewed by adjacent residents as desirable.				X									X	X	X	X		X		X	X		X			X	
SM-14	Construct armoring structures such as sea walls, sea dikes, revetments, and bulkheads.	Flooding and wave damage in low-lying areas from major storm events can threaten human investment.	Prevents inland flooding from major storms accompanied by large, powerful waves.	A seawall is typically a massive, concrete structure with its weight providing stability against sliding forces and overturning moments. Sea dikes are typically earth structures (sand and clay) that protect low-lying areas against coastal flooding. Bulkheads are vertical retaining walls to hold or prevent soil from sliding seaward to reduce erosion and protect against wave attack, but can also protect against flooding and wave action. Revetments are erosion-resistant material placed directly on an existing slope, embankment, or dike to protect against waves and strong currents.	Very high initial costs relative to "softer" approaches such as beach nourishment. Annual O&M costs are required. Seawalls must often be supplemented with beach nourishment. Erosion of the seabed immediately in front of the seawall is exacerbated due to increased wave reflection, which results in a steeper seabed profile that subsequently allows larger waves to reach structures.	Armoring structures can interrupt natural littoral drift processes and can starve the supply of sand to downdrift beaches. The negative, downdrift impact on the local and regional sediment budgets can be a key environmental constraint. Seawalls, in particular, can trap sediment behind the structure and prevent it from contributing to sediment transport processes along the coast. Some of these impacts can be reduced with beach nourishment.	Armoring structures have been replaced with softer approaches (such as beach nourishment) over the past several decades. Armoring structures often have less support from resource agencies due to impacts such actions create. Some view armoring structures as having negative impacts to aesthetics, surfing, views of the coastline, and access to public beach and swimming areas.					X	X					X									X					

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SM-15	Beach nourishment	Waves can erode beaches and increase coastal flood risk.	Prevent shoreline erosion and protect against flooding. Beach width is increased.	Loose sediment can be placed on subaerial beaches. Placement can be made as underwater mounds across the subaqueous profile or as dunes to rebuild existing dunes. The material is placed on the eroded part of the beach to compensate for the lack of natural supply of beach material. The increased sand buffer accommodates short-term sediment losses so that storm waves and runup dissipate over the wider fill profile. The beach fill might protect not only the beach where it is placed, but also downdrift stretches by providing an updrift point source of sand.	Low initial costs relative to traditional, "harder" approaches. Annual O&M costs include regular additions of beach nourishment.	Beach nourishment can enhance the natural environment by bringing new material to sand-starved beaches and expanding the beach habitat. Widened beaches reduce the potential for new, tidal inlet formation during storms at narrow reaches of barrier islands. However, negative environmental impacts can result from offshore, sand borrow sites.	Beach nourishment can lead to recreation and tourism benefits.					X						X				X				X		X	X		X				
SM-16	Nourishment of natural or artificial dunes	Waves can erode beaches and increase coastal flood risk.	Prevent shoreline erosion and protect against flooding.	Dune construction is the piling up of beach quality sand to form protective dune fields to replace those washed away during severe storms. An essential component of dune reconstruction is planting of dune vegetation and placement of netting to help retain wind-blown sand normally trapped by mature dune vegetation.	Low initial costs relative to traditional, "harder" approaches. Annual O&M costs include regular nourishment of dunes.	Dune construction can enhance the natural environment by bringing new material to sand-starved beaches. However, negative environmental impacts can result from offshore, sand borrow sites.	Dune construction can lead to recreation and tourism benefits.					X						X				X				X		X	X		X				
SM-17	Construct a storm surge barrier with movable locks or gates	Storm surge flooding and related wave attack can impact estuaries. Excessive intrusion of saltwater wedges during high-water episodes can occur.	Protection of estuaries against storm surges, yet maintain tidal estuaries. Potentially allow for navigation.	A storm-surge barrier separates an estuary from the sea by movable locks or gates. The movable gates would stay open during normal conditions, but close at very high storm-surge events. The closed gates would help armor the shore during storms. The gates would be sliding or rotating steel constructions, supported in most cases by concrete structures on pile foundations.	High initial costs and high annual O&M costs.	Opening the gates would help maintain saltwater ecology of tidal estuaries.	Flexibility in operation could help balance the needs of multiple stakeholders.					X						X				X	X			X		X	X			X			

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SM-18	Construct shoreline stabilization, such as breakwaters, groins, sills, and natural or artificial reefs.	Erosion reduces the sediment buffer zone between the land and the sea. Erosion translates into storm damage from flooding and wave attack. Chronic erosion becomes a problem due to diminished sediment supply.	Shoreline stabilization moderates the long-term average erosion rate of shoreline change from natural or manmade causes.	Breakwaters are detached, generally shore-parallel structures that reduce the amount of wave energy reaching a protected area. Groins are retention structures that are perpendicular to the shoreline and that act as a barrier to longshore sediment transport. Natural reefs (platforms of biotic organisms built up to an elevation) and artificial reefs (designed for shore protection, beach renourishment, and surfing) also reduce wave energy. Submerged offshore sills interrupt movement of sediments and reduce wave energy.	High initial costs relative to "softer" approaches, such as beach nourishment.	Shoreline stabilization that moderates coastal sediment transport processes could result in starving the supply of sand to downdrift beaches. The negative, downdrift impact on the local and regional sediment budget could be a key environmental constraint. Some of these impacts could be reduced with beach nourishment. Breakwaters and sills function by modifying the near-shore wave environment.	Coastal zone management policy in many countries and the United States currently discourages the use of groins for shore protection because of the many examples of poorly designed and improperly sited groins. Submerged stabilization, such as sills and artificial reefs, generally have fewer adverse effects on surfing conditions than structures visible from the surface.					X								X					X			X		X				
Operation and Maintenance																															
OM-1	Restore channel form and function to improve O&M and facilitate reduction of flood damage.	Natural river/stream channels are formed by fairly frequent runoff events. Often, these channels are not large enough to handle peak flows from larger floods and upstream reservoir releases. This results in channels with inadequate capacity that can inhibit drainage and contribute to flooding. Narrow channels also tend to increase velocity of flows, which can increase erosion and the risk of flood damage.	Where applicable, channels could be enlarged enough to safely carry larger peak flows without causing excessive erosion or other damage to the flood management system.	Restoring channel form and function to design standards would involve excavating a new channel or enlarging an existing channel. This would increase channel capacity and/or decrease the channel velocity. Areas adjacent to the thalweg or low-flow channel could be used to encourage or maintain sensitive habitat while other sections of the channel prism could be maintained for flow. Restoring channel form and function could occur in an existing river channel, an existing floodway, or a transitory storage area.	Initial costs, depending on the project, would likely require a moderate to high level of initial investment due to permitting, real estate needs, mitigation costs, and structural changes. A potential decrease in annual costs exists.	Low-flow channels can be used to encourage or maintain sensitive habitat while other sections of the channel prism could be maintained for carrying flood flows. This could result in moderate to substantial temporary (and potentially permanent) impacts to upland, riparian, and aquatic habitats. Extensive and complex permitting would be required.	Could have substantial neighborhood, community, and environmental interest opposition.	X	X							X						X		X	X							

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OM-2	Perform clearing and snagging within channels.	Snags are trees, limbs, or large bushes that have fallen into a stream or river. Once in the waterway, they can collect sediment or debris. Although snags provide important ecosystem benefits (large woody debris provides excellent fish habitat), they could migrate downstream and become stuck in the channel, which could create snag "islands" and reduce channel capacity. Snags could cause property damage by becoming caught on bridges, pumping plants, docks, or other infrastructure. Debris could create drag and reduce channel capacity, but in some areas might serve as bank protection.	Channels should be clear of snags and large debris to maximize capacity.	Clearing and snagging could be performed to remove snags and large debris located within channels.	Low level of initial costs and no significant change in annual O&M costs exist.	Snagging would result in moderate to substantial temporary impacts to riparian habitat during removal, and would result in permanent impacts with loss of foraging and rearing habitat for fish species. Clearing of vegetation would result in substantial permanent impacts to riparian habitat, nesting birds, and aquatic species. Substantial permitting would be required.	This measure would improve public safety but would reduce existing shaded riverine aquatic habitat, which is an important component to some ecosystem restoration programs. Public support might be mixed.	X	X							X												X						
OM-3	Perform dredging to remove sediment from channels.	Sedimentation of natural channels reduces their flow-carrying capacity. Sedimentation that has been caused by erosion of riverbanks and levees, runoff from agricultural fields and in some areas, historical hydraulic mining, are natural occurrences of sedimentation.	Channels should be clear of accumulated sediment to maximize capacity.	Dredging could remove sediment from channels, which could improve the hydraulic efficiency. Deepening the thalweg or creating one could increase the overall flow efficiency by increasing the velocity through it.	Dredging projects would likely require a high level of initial costs. Dredging might reduce annual O&M costs due to fewer repairs of scour and erosion.	This action would result in moderate to substantial impacts to riparian and aquatic habitat (fish spawning and rearing habitat). It also would result in minor to moderate alteration of physical processes, including flow regime and sediment transport. Considerable and extensive permitting would likely be required.	Would likely need to be performed in areas of low environmental impact to be implementable.	X	X							X							X					X				
OM-4	Reuse excess materials derived from channel maintenance.	Waste materials are created during channel maintenance activities such as dredging, clearing, and snagging. It is necessary to transport and dispose of these materials, which can be costly.	These materials should be reused to minimize waste and transportation costs. Reuse also reduces negative impacts to the environment, including carbon emissions and disposal to landfills.	Beneficial reuses for waste materials from channel maintenance activities should be identified. Dredged sediment, if it does not contain hazardous materials, could and should be used where appropriate.	Reusing excess materials should reduce waste and transportation costs. No significant changes in annual O&M costs exist.	Environmental impacts would vary by project.	Reuse of excess materials would be highly likely to be implemented due to the potential cost savings and reduction in negative impacts to the environment.	X	X									X					X								

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OM-5	Develop regional channel vegetation management plans.	When vegetation management has been deferred for several years due to funding or other constraints, excessive vegetation growth could result in the establishment of habitat that requires additional permits or mitigation before maintenance activities could be conducted. Conflicting requirements in relation to vegetation and debris management could make conducting efficient maintenance activities difficult for local agencies with limited budgets.	Develop channel conveyance management plans as part of corridor management that would balance public trust concerns while maintaining the functionality of the flood management system and would allow for regular maintenance to ensure public safety.	Vegetation management plans should be developed using a collaborative process involving stakeholders. Architectural Landscape designs should be developed in coordination with structural designs.	Cost of mitigation is high. Regional vegetation management plans would slightly increase annual O&M costs, but would reduce mitigation and permitting costs.	Regional vegetation management could rehabilitate key physical processes and ecosystem functions, such as sediment transport, channel and floodplain forming processes, and enhancement of riparian and wetland habitat values. Permitting requirements would be channel specific.	Likelihood of implementation is highly dependent on the ability to meet requirements.	X	X									X				X				X		X	X		X		
OM-6	Develop encroachment management programs.	Several jurisdictions are responsible for processing, reviewing, issuing, and administrating permits for structures that encroach on project levees. There are hundreds of permitted encroachments that are not properly maintained and hundreds of unpermitted encroachments statewide. Unmaintained or unpermitted encroachments might jeopardize flood facility integrity, raise the water surface level of design floods or flows, increase the damaging effects of flood flows, and impair inspection, maintenance and flood fighting.	A streamlined permitting process, proper administration of existing permits, creation and/or improvement of a permit database, and vigorous enforcement of unauthorized permits. Watercourses free of obstructions and encroachments.	Improve the administration of encroachment permits by discouraging new encroachments, removing illegal encroachments and improving enforcement of unauthorized and under-authorized permits. Improve management of historical permit data by creating or improving a repository of encroachment permits. In addition, encroachment permits should consider within the asset/legal-liability framework.	Low initial costs. No significant change to annual costs.	None.	Feasible and likely implementable. Could require significant administrative work and collaboration among many agencies.	X	X					X				X													X
OM-7	Provide administration and oversight of levee penetrations.	Many levees and other flood facilities have locations where irrigation lines, drainage outlets, and other utilities have been piped through the levee. Some of these penetrations are engineered, but many are not and pose a potential threat to the integrity of the levees. Leaks through the levee resulting from penetrations could cause excessive damage to flood facilities.	An inventory of all penetrations, permitted and otherwise, creation of a database for all penetrations, and an assessment of deficiencies associated with penetrations.	Improve administration and oversight of levee penetrations by creating a data management system to track, evaluate, and permit penetrations. Establish a protocol to periodically conduct noninvasive testing on levee penetrations to assess their deterioration and recommend an adequate course of action. Upgrading standards for construction of new penetrations.	Cost for removal of penetrations varies, depending on the extent of administrative improvements. Low to moderate annual costs. Most of the annual costs are associated with physical testing of levee penetrations that pose a hazard to flood protection.	Repair or relocation of levee penetration might have temporary impacts to riparian or other habitats.	Feasible and likely implementable. Need to engage the owners and operators of levee penetrations. Small and nonurban communities might not have the necessary resources to address deficiencies found.	X	X					X				X													X

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OM-8	Improve interior drainage.	Localized flooding could occur even while the larger conveyance paths for streams perform well. Local flooding could influence flooding at larger scales by increasing discharges downstream or backing up water upstream.	Improve interior drainage by channeling runoff to prevent flooding, help eliminate backwater effects, and ensure each watershed has sufficient capacity.	Interior drainage could be improved by modifying or constructing new outfalls. Outfalls with flap gates could prevent backflow from rivers or channels entering interior areas. Also needed would be new or improved pump stations, or new interior drainage detention/retention facilities.	Moderate to high initial costs, but costs are project dependent.	Wide variety of environmental impacts could result, based on type of project.	Interior drainage is typically a local function, and implementation would depend on local resources, needs, and acceptability.	X	X						X			X												
OM-9	Protect vulnerable levees and banks through stabilization and erosion repairs.	Erosion can encroach on existing flood facilities and ultimately result in facility failure and major flooding. Floodwaters are erosive and, while moving along typically unprotected flood facilities, need only encounter one weak spot to cause a breach and potential loss of life or property. Extremely high hydraulic gradients could find other weak spots in the foundation materials and begin to migrate, or erode material from the foundation, creating unstable conditions quickly followed by total or significant structural failure (Flood Emergency Action Team, *Final Report of the Flood Emergency Action Team*, "Chapter VII. Flood Control System Improvements." 1997). In some places, ongoing erosion could cause more damage than can be repaired by the State or local agencies using standard maintenance programs.	A long-range solution to perform proactive repairs on damaged sites exhibiting signs of under-seepage, erosion, or instability, so such situations do not reach a critical state of failure.	Erosion repair and bank stabilization, particularly when done in emergency situations, would be made using rock riprap to armor and stabilize the bank. If conducted as part of an ongoing inspection and maintenance program, erosion repair and bank stabilization could be made more environmentally friendly by reexamining current geomorphic processes, using natural materials where practical, and including sloping riparian benches with vegetation on the bench for bank stabilization and riparian habitat. In-stream habitat, such as log and debris structures to direct flows away from flood facilities, could be created as part of these repair activities.	Medium to high initial costs due to structural changes and potential mitigation. Could decrease annual O&M costs due to better performing levees and less erosion to repair	Depending on implementation, this action could result in potential temporary and permanent impacts to shaded riverine aquatic and riparian habitats. Planting of native riparian vegetation could offset some of these impacts. Levee repairs that include riparian habitat benches and in-stream habitat elements would rehabilitate ecological functions.	Potential for neighborhood, community, or environmental interest opposition.	X	X			X		X				X				X						X					

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OM-10	Revise O&M manuals to be consistent with new and current policies that support multiple benefits of the flood system.	Outdated O&M manuals do not reflect the best maintenance practices to inspect, operate, and maintain levees most effectively. Many existing O&M manuals were prepared specifically to reduce flood risks, often with little consideration about how those O&M activities might affect other functions of the flood management system, including ecosystem functions.	O&M manuals that reflect best maintenance practices and scientific based approach to multiple benefit management of the flood management system, and that are in compliance with current laws and regulations.	Revise O&M manuals, or provide an addendum to O&M manuals that promotes best maintenance practices using the best available scientific and technical data to support multiple objectives and ecosystem benefits. The revised O&M manuals should be complementary to achieve multiple benefits. Operation and Maintenance documents should be reviewed and updated to reflect current maintenance intervals, laws, regulations, and policies.	Low to medium initial costs, depending on the number of manuals that need to be, and can be, updated to achieve these goals. Updating O&M manuals could decrease annual O&M costs.	Including the enhancement of physical processes and ecosystem function in O&M could rehabilitate those processes and functions.	Concerns over limiting the flexibility to maintain integrity of the flood management system must be overcome. However, the potential to provide recreation, open space, and water supply benefits will be met with support by some interests.	X	X									X	X		X		X	X		X	X		X			
OM-11	Effectively maintain, operate, and rehabilitate closure structures.	Many levees are interrupted by crossings and other at-grade penetrations that lower the top-of-levee elevation. Such crossings include railroad tracks, roads and highways. Many of these levee gaps are fitted with structures that would be closed during periods of high water to prevent inundation of the protected area. Other gaps do not have such closure structures. Some closure structures installed have not been maintained to allow functional operation during flood events.	All gaps in levee alignment should be evaluated periodically, and closure structures should be installed at gaps where warranted. All closure structures should be operated and inspected at established regular intervals to ensure that the structures will function during flood events.	All gaps on the levee control system need to be identified, and local agencies must evaluate gaps without closure structures to assess whether a structure is warranted. Existing closure structures need to be evaluated for deficiencies in design and maintenance and need to be operated on a regular basis to make sure they will operate effectively during emergencies. The State needs to establish closure structure operation drill and inspection protocols to be carried out by local structure operators.	Initial costs to design and install closure structures are potentially high. Very low annual costs associated with operational drills and upgrades to the closure structures.	There will be environmental impacts that will vary by project.	Existing closure structures may need to be upgraded and all need to be operated on a regular basis. The USACE requires that all closure structures be in good conditions and that trial erections have been accomplished in accordance with related O&M manuals. Institutional, funding, and community relations challenges exist.	X	X									X													
OM-12	Develop and/or implement structure rehabilitation and repair programs.	Many flood control structures are aging and approaching the end of their useful life. If not rehabilitated or repaired, some structures may fail or become functionally obsolete.	To have structure rehabilitation and repair programs that would monitor the rehabilitation needs of aging structures.	Create programs that monitor the status of existing structures; repair those structures that have been identified as beyond their useful life.	Medium to high initial costs. Developing a monitoring program could be very costly, depending on number of structures included in program and on the ease of accessibility. Increased annual costs due to increased repair costs.	Potential for adverse environmental impact exists during rehabilitation of structures.	Substantial institutional and funding challenges exist.	X	X									X													

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OM-13	Develop a long-term sustainable and implementable Levee Vegetation Management Strategy	In some areas, the vegetation on levees can prevent adequate visual inspections, and present access challenges. In addition, some areas of legacy levees with large wood vegetation present a challenge in implementing O&M functions to conform to all existing regulations. The current allowable site-by-site variances are limiting and require significant resources to gain approval.	A levee vegetation management strategy that focuses on a balanced approach to support both public safety and environmental protection. Continued research into improving the science behind levee vegetation management.	Develop a levee vegetation management strategy that focuses on enforcing visibility and accessibility criteria, and that develops a life-cycle monitoring and maintenance strategy for vegetation using a collaborative process among stakeholders. Regional variances with a broader geographic extent would be more efficient than a site-by-site variance process.	Low initial costs. Policy management actions will tend to have lower initial costs. Low to moderate increase in inspection costs, depending on the adoption of a new set of inspection criteria. Maintenance costs may also be impacted, depending on the final adopted set of inspection criteria.	Vegetation removal may create adverse environmental impacts.	Policy differences on levee vegetation exist among many local, State and Federal agencies	X	X									X	X			X			X		X			X	
OM-14	Remove sediment from and investigate capacity of debris basins	Debris flows gradually fill up debris basins. Debris flows can increase significantly as a result of wildfires. Debris basins must be cleaned when sediment accumulates and capacity is reduced.	Debris basins that have capacity to retain sediment.	State and local agencies would conduct assessments of adequacy of strategically located debris basins under a range of scenarios in urbanized areas in light of increased fire and post-fire debris-flow events. Sediment would be removed to provide capacity to retain sediment. Extracted sand and gravel may potentially serve as a source for fill and aggregate for local construction. However, sediment often needs to be disposed of at a landfill.	Removing sediment from debris basins is a significant long-term O&M cost. However, deferred maintenance of debris basins reduces their ability to provide flood protection.	Environmental impacts can vary dependent on how sediment is disposed of or used.	Local agencies may lack funding to regularly remove sediment from debris basins.			X	X							X							X						
OM-15	Conduct dam safety inspections and investigations	Dam failure can result from earthquakes, failure of upstream dams, extreme storm events, and other factors. Dam failure can result in catastrophic flooding in areas downstream.	Dams that are regularly inspected and evaluated for safety.	Inspect dams annually to ensure that they are performing and being maintained in a safe manner. Conduct follow-up investigations and impose corrective actions, retrofits, or upgrades as needed, such as imposing restrictions on reservoir water surface levels.	Low. Annual costs for inspection and investigations are low compared to management actions that that involve physical construction.	None.	Likely to be supported by Federal, State, local agencies and communities. Institutional and funding challenges exist.							X				X										X			

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Land Use Planning																														
LU-1	Reduce flood damages through acquisitions, easements, and private conservation programs.	In many areas, natural floodplains have been reduced, and floodplains are isolated from rivers and streams. This has led to constrictions to flow that create flood hazards, present maintenance problems, and result in loss of ecosystem quality and function.	Acquire or otherwise dedicate floodplain land that is now not subject to flooding to the flood management system in sufficient amounts and at appropriate locations so that the increased floodplain transient storage lowers flood peaks, restores river processes, enhances ecosystem value, and contributes to water supply management.	Lands adjacent to channels and coasts that have been flooded during periods of high flow would be inundated more frequently, at greater depths, or for longer periods of time. However, this must be balanced against the impact to existing land uses and critical infrastructure in floodplains. The use of voluntary flood easements could accommodate floodwaters, preserve agricultural land, and provide habitat. In addition, private land conservation programs could be expanded through developing partnerships and incentive programs.	Potentially high initial costs, depending on location and extent of floodplain acquisition. Could increase annual costs for floodplain maintenance.	Could rehabilitate key physical processes and ecosystem functions. Moderate to substantial permanent impacts to terrestrial, agricultural, and potentially to seasonal or freshwater marsh wetland habitats. Minor permitting required.	Implementation is highly variable due to location and geographical extent of land acquisition. Acquisition of some property, whether land or structures, may be necessary to ensure the effectiveness of the flood management system. Institutional, legal, funding, and community relations challenges exist.	X	X	X	X	X	X	X	X		X		X	X		X		X			X				
LU-2	Develop local flood management plan updates	The most recent and applicable data are not always available or used for updates to local flood management and land use planning documents, resulting in outdated planning strategy and reduced benefits. Many flood-related regulations and planning are associated with a defined level of protection or an event of certain return frequency, which is subject to change based on hydrological record. Some local agencies are limited in their capacity to update local flood management plans and might require institutional and technical support.	State and local agencies would manage floodplains more proactively and adaptively and would have access to the most recent hydrologic, climate, physical and biological conditions, policies, and land use data in order to adequately update planning documents for land use and flood management.	The approach would consist of General Plan updates, local flood management plan updates, regional general permitting, Natural Community Conservation Plans (NCCPs), Habitat Conservation Plans (HCPs), and other planning documents and enactment of local zoning amendments to increase level of protection. New data developed by local agencies for flood management planning purposes (i.e., new hydraulic models) would be integrated into planning documents when updated.	Low initial costs. Measures include policies, plans, improved tools, and do not involve physical construction. No impact on annual O&M costs in the short-term. Potential decrease in long-term annual O&M costs.	Dependent upon content of local plans.	Overall, improved land use management would be favorable to overall general public, government agencies, but some resistance by cities/counties that depend on tax base and development industry.	X	X	X	X	X	X	X	X		X		X			X				X			X	X
LU-3	Provide information and data to assist local communities in planning and evaluating land use proposals on alluvial fan areas.	Practices utilized to address alluvial fan conditions generally lack consistency in California. Local governments that plan for and evaluate future development on alluvial fans sometimes have an insufficient understanding about alluvial fan flooding.	Increased awareness among local communities to plan and evaluate land use proposals in alluvial fan areas	The State, local agencies, and universities would identify a process to create and maintain a web-based portal that allows interested parties to access the pre-project screening and flood management tools and data for hazard and resource evaluation for special alluvial fan areas being planned or proposed for development.	Medium initial costs needed for coordination, data gathering, and outreach. Low annual costs.	None	Would require significant coordination across local agencies. Significant educational outreach would need to be conducted to promote the web-based portal.				X					X													X

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LU-4	Managed retreat.	In some areas, coastal flood risk is high and shoreline protection efforts and/or their repeated maintenance is costly and ultimately ineffective at preventing further erosion.	Reduced consequences of coastal flooding	Allows the shoreline to advance inward unimpeded. As the shore erodes, buildings and other infrastructure are either demolished or relocated inland. A managed retreat approach typically involves establishing thresholds to trigger demolition or relocation of structures threatened by erosion. The term "managed retreat" has been used to describe policies ranging from complete removal of all shore protection structures to simply not allowing new structures to be built.	Initial costs are usually needed to relocate and demolish structures that will be flooded. Little to no annual O&M costs.	Maintains natural shoreline dynamics and enables shoreline habitats to migrate inland as the shoreline erodes	Can be politically difficult to implement, especially where significant development has already occurred. May cause depreciation of shorefront property values. Gaining widespread political support would be critical for success.					X	X				X									X				
LU-5	Designate lands for dedicated flood flows.	Not all jurisdictions have lands designated for dedicated flood flows. Where they do exist, they are often outdated and do not reflect recent changes in hydraulic or hydrologic conditions.	Additional floodways could be designated to ensure consistency with the current understanding of hydraulic and hydrologic conditions.	Designated floodways are channels of the stream and that portion of the adjoining floodplain reasonably required to provide for the passage of a design flood. Designated floodways help improve a community's level of protection. This management action would update the State's designated floodway program or would update or create other similar local designations. This effort would be integrated with the recent hydrologic and hydraulic modeling results.	Low initial costs. Nonstructural management actions would tend to have a substantially lower capital cost than other management actions that involve physical construction. No change in annual O&M and repair costs.	Similar to adoption of a land use general plan, if changes to policy or regulations would result in project implementation (e.g., physical impacts), CEQA compliance would be required. Permitting might be required if policy is implemented and if there are impacts to regulated resources.	Might eliminate opportunity for urban development within boundaries of new floodways. However, could provide opportunities for other development, both within the new designated floodway (agricultural, recreational, and habitat uses) and in neighboring communities that might have the benefit of improved flood protection.	X	X	X	X	X	X	X	X		X					X		X	X	X	X				

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LU-6	Encourage compatible land uses with flood management system and floodplain function.	Urbanization in floodplains increases the potential for flood damage to homes, businesses, and communities. Land use decisions made at the local level often allow development in floodplains and create situations that are incompatible with flood management systems and existing flood protection for the area. With a limited understanding of the beneficial functions of floodplains, assertions have been made that floodplain management decisions are outside the context of watershed-level planning and have inadequate consideration of natural and beneficial floodplain functions.	Provide an opportunity to better plan development that is more compatible with flood management by coordinating land use decisions. Decisions made at the local level that provide flood protection could benefit the community with areas of open space, parkways, trails, or habitat lands.	Delineate appropriate and allowable urban and rural land uses within floodplains and identify ways, where feasible, that flood-prone lands can serve multiple uses (i.e., groundwater recharge, recreation, or habitat). Define criteria for development in flood-prone areas, promote Low Impact Development (LID) techniques, and conduct research on compatible cropping or agricultural practices for certain agricultural areas with high risk of flooding. In coastal areas, this could include defining coastal construction setback lines and zones that restrict construction close to the shoreline.	Low initial costs. Measures would include policies, best management plans, financial incentive programs, educational programs, and would not involve physical construction. Would likely lead to decrease in annual O&M costs.	Could result in rehabilitation of key physical processes and ecosystem functions by identifying and setting aside areas where rehabilitation would be most beneficial for habitats and flood management and restricting development there.	Implementation would be compatible with State policy for preserving land use authority within local jurisdictions. It also would be compatible with current legislation requirements in the Central Valley to address flood hazards in local land use planning. Cities and counties located in floodplains might resist restrictions that limit their development.	X	X	X	X	X	X	X	X		X		X	X		X		X			X			X	
Floodplain Management																															
FM-1	Manage municipal stormwater to provide regional or systemwide flood benefits.	Municipal storm flows exhibit accelerated runoff and higher peak flows than an undisturbed landscape. These characteristics create more scour, higher stages, more dangerous channel velocities, and generally more destructive flows, and they occur over a shorter period of time than flows from an undisturbed watershed.	Develop municipal stormwater improvements to improve flood management while providing other benefits, such as ecosystem functions.	Stormwater management is governed and implemented by municipalities and other local agencies. There are opportunities to coordinate local stormwater management with regional flood operations and to explore the treatment and reuse of stormwater. Examples of implementation include replacement of hardscape surfaces with vegetative surfaces; use of diversion channels to collect excess surface water and convey it for infiltration; use of vegetated waterways; use of terracing to reduce the volume and velocity of runoff from sloped land; diverting floodwaters from recharge facilities to in-stream flows to improve water supply and quality.	Low to moderate initial costs to implement on large scale and no change in annual O&M costs.	Potential to provide environmental mitigation and enhancement opportunities.	Stormwater management falls under local, municipal, and State jurisdictions; large-scale implementation (to provide systemwide flood benefits) would require coordination by a large number of local, municipalities, and State agencies, which would likely require changes to stormwater policies at regional (cities, counties, integrated water organizations), State (Water Boards), and Federal (USEPA) levels. Institutional, legal, funding, and community relations challenges exist.	X	X	X	X	X	X	X	X	X			X	X		X		X	X	X	X			X	

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FM-2	Coordinate and streamline floodplain mapping to improve consistency of floodplain delineation and assessment of flood risk	Floodplain boundaries provided by USACE, FEMA, and DWR are often different from each other due to variation in the available data and intended purpose of the map. Inconsistencies between the floodplain boundaries of multiple agencies can cause public confusion regarding flood risk.	Improved accuracy and understanding of current and new floodplain maps to help guide development, prepare plans for community economic growth and infrastructure, utilize the natural and beneficial function of floodplains, and protect private and public investments. Increased awareness of the different types of maps and their appropriate uses.	This approach would involve the development of a unified set of floodplain-mapping standards for the foundational data sets used for topography, hydrology, hydraulics, and floodplain delineations to ensure consistent floodplain delineation and assessment of flood frequency and risk. This would support coordination with other hazard mapping efforts to create, develop, produce, and disseminate geographic information system (GIS)-based multi-hazard advisory maps.	Medium to high initial costs for coordination, database, and data collection. Small increase in annual costs.	Possible indirect environmental impacts	Would require consensus on standards and database population. Potential to discourage development in floodplains.	X	X	X	X	X	X	X				X													
FM-3	Increase flood risk awareness through outreach.	Among the public there is a general lack of understanding of flood risk because of limited access to information, a false sense of security, and an undefined responsibility for education. Many property owners assume that if they are outside the 100-year floodplain, they are safe. Some also wrongfully assume that 100-year-certified levees will protect them against any level of flooding. State, Federal, and local flood control agencies have struggled to educate the public with a comprehensive and consistent message on flood management.	Improved public awareness of flood risk, what households and businesses can do to reduce or mitigate risk to acceptable levels, need for flood insurance, requirements associated with the use, buying, and selling of property, available assistance programs, what to do in a flood event, and how floods might occur. Increased awareness might help build political support for the public's willingness to invest in necessary flood management activities.	Expand outreach programs to include public service announcements, workshops, social media, and other outlets that increase public awareness of floodplain values, flood risks and hazards, how FEMA maps are developed and used to assess flood risk, public safety, and hazard mitigation measures. Develop an interactive website that would allow users to access detailed flood hazard maps. Students could be educated about flood risks as part of their curriculum. Coordination and sharing knowledge between State and local flood managers is key. Information should be presented in a way that would not result in public panic.	Low initial costs. Policy and outreach management actions might tend to have a substantially lower capital cost than other management actions that involve construction. Examples of capital investments include funding for training, education, and promoting awareness of flood risk among the public and those responsible for implementing floodplain management decisions. Low to moderate annual costs, depending on how often flood information is disseminated.	None	High likelihood of implementation.	X	X	X	X	X	X	X	X		X													

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FM-4	Increase local agency awareness of flood mitigation compliance and grant application assistance.	Many local agencies would benefit from assistance in pursuing Federal and State grants to mitigate flood risk. Many State and Federal agencies have funding sources to assist local jurisdictions with their flood risk issues. Within these agencies, there are multiple programs that locals may not be completely familiar with. Local project opportunities are sometimes not planned or implemented because of lack of knowledge about the available grant programs. Establishing a clear roadmap for local agencies and identifying the best programs for their needs is a service that is not readily available at this time.	Increased local jurisdiction participation and awareness of various State and Federal programs available. Increased participation and awareness in FEMA's Flood Mitigation Assistance (FMA) Program, FEMA's Pre-Disaster Mitigation Grant Program, and FEMA's Hazard Mitigation Grant Program. Stronger partnerships and participation with all levels of government to maximize resources in support of State and Federal programs.	Increase awareness of local agencies and practitioners on the availability of FMA grants and other Federal and State programs. Greater coordination at all levels of government to integrate programs at a local, State, and Federal level.	Low initial costs. Outreach management actions tend to have a substantially lower capital cost (need more staff to accomplish) than other management actions that involve physical construction. Could require initial cost outlay for more staff. Potential to reduce annual O&M costs; FMA grants are used to support programs that reduce long-term risk for flood damages. Improvements to the flood control system might reduce O&M costs.	None	High likelihood of implementation; minimal costs for the State to assist localities in grant applications with potentially large benefits.	X	X	X	X	X	X	X	X		X														
FM-5	Increase awareness of and participation in the Community Rating System (CRS) insurance-rate adjusting program.	The CRS is a FEMA program created to encourage and recognize communities that engage in floodplain management activities that exceed minimum National Flood Insurance Program (NFIP) standards. Despite the reduction in flood insurance premiums offered to participating communities, only 14% of California communities (which accounts for 55% of the NFIP policy base statewide) are participating in the CRS program. Communities lack staff and time to apply and maintain program requirements.	Increased participation and existing CRS classifications in the CRS program.	Outreach, train, and educate the public and local agencies about the advantages of participating in the Community Rating System program.	Low initial costs and annual costs. The only costs associated with this action would be the creation of a CRS Coordinator position at the State level and outreach and training costs.	Could possibly improve key physical and ecological functions through stricter requirements.	This action would be easy to implement. There are other State and local programs where coordination regarding education and outreach already occurs and these could be used as a model. High, great support at the local, State, and Federal level for the CRS program. Also high level of public support for this program.	X	X	X	X	X	X	X			X														

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FM-6	Develop mandatory flood insurance programs that are more consistent with the area's risk of flooding.	Under the current rules of the NFIP, homes protected by levees certified by the USACE as providing 1 percent chance event flood protection are not required to obtain flood insurance. However, occupants protected by flood infrastructure are still exposed to a residual risk from flooding due to unforeseen factors such as poor construction, poor maintenance, undetected rodent activity, undetected geotechnical problems, seismic events, and tsunami events. Furthermore, while flood infrastructure can reduce the occurrence of flooding, they do not protect against the consequences of more severe floods.	Those subject to residual flood risk are protected by flood insurance and property owners in all flood zones carry flood insurance.	Coordinate with FEMA to graduate Federal flood insurance premiums according to a structure's level of flood risk rather than the structure's location (based on a combination of frequency and actual damages). Additional information besides Flood Insurance Rate Maps (FIRMs) would be used for decision making. This could include creation of a flood hazard zone for areas protected by flood infrastructure and structures protected from less than the 0.5% chance event floodplain, where Federal flood insurance would be mandatory but with preferred risk options. New buildings sited within the zone would pay actuarial based insurance rates.	Variable costs, depending on the geographical extent of areas requiring flood insurance based on new flood risk zones.	Could possibly impact physical and ecological functions. Permitting decisions would be impacted in areas behind levees.	Could be difficult to implement. FEMA and the State would need to cooperate and possibly change the way flood risk is determined and the rates that should be paid for protection. This could also cause some people who were not previously considered in a flood risk area to be required to buy flood insurance. Politically sensitive subject requiring high-level coordination at Federal, State, and local levels. Similar proposal has been made at Federal level.	X	X	X	X	X	X	X	X			X															
FM-7	Develop a State program and framework to reduce or eliminate subsidies for repetitive loss properties in flood-prone areas.	There are instances where owners of property within the floodplain have accumulated insurance claim reimbursements equal to or greater than the value of the structure for repeated flood damages.	Reduced flood insurance liability and reduced loss of lives and property and tax burden to State and Federal taxpayers.	Identify opportunities independent of FEMA to identify and eliminate subsidies for structures that are repetitively damaged. Work with FEMA and local communities to terminate Federal flood insurance for property owners who have accumulated claim reimbursements equal to or greater than the value of the structure or require reimbursements to be used towards flood mitigation measures, such as relocating, elevating structures, flood proofing, or demolition if the structure is repetitively or substantially damaged.	Low/medium initial costs. This management action would save money by reducing the amount that can be paid for repetitively damaged structures by the NFIP but may require some funds for mitigation. Annual cost would be greater in first few years until program was fully phased in and benefits realized.	None	There could be resistance to this action because many payees would resist moving their structure or the redirection of insurance payments to other flood management activities. This would require a major policy change to enact, which has already been proposed at the Federal level and has been met with significant political challenges.	X	X	X	X	X	X	X	X		X														

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FM-8	Construct flood infrastructure that would redirect floodwaters, subdivide larger basins, or isolate inundation.	If a small portion of a flood facility fails within a system that protects a large and heavily populated area, the entire area could be inundated. Constructing levees, floodwalls, or other flood infrastructure that subdivides the basins could limit the inundation following facility failure. Training levees could redirect the erosive forces of floodwaters to reduce the likelihood of flood infrastructure failure.	Isolated failure of a flood control system that does not inundate the entire basin (or lands) that it protects.	In areas where flood control systems protect large areas, perform analyses to determine the best location for a subdividing levee, floodwall, or other infrastructure to minimize and isolate the risk of primary facility failure. Perform analyses on existing flood control systems to determine areas susceptible to erosive force and failure, and construct infrastructure to reduce the risk of failure.	Medium to high initial costs. Training levees are often relatively short to be effective. Subdividing levees and other flood infrastructure could be long with a significant cost. Both training levees and subdividing infrastructure would require regular maintenance, and likely could incur significant repair and rehabilitation following flood events.	Construction of training levees could significantly impact existing riverine/riparian habitat. Construction of subdividing flood infrastructure may impact habitat, depending on siting. Extensive and complex permitting.	Would require State or local stakeholder leadership to succeed. Institutional, funding, and community relations challenges exist.	X	X	X	X	X	X	X	X	X												X					
FM-9	Use floodproofing measures, such as wet or dry floodproofing, raising, or relocating structures.	Structural measures cannot provide complete protection against flooding. Owners of structures located in floodplains may want to use floodproofing measures, such as wet or dry floodproofing, raising, or relocating structures.	Increase resilience of buildings, and reduce flood damage and required time for recovery.	There are different floodproofing measures such as dry floodproofing (keeping water from entering a structure), or wet floodproofing (allowing water to enter the building with minimal interior damage). In order to raise a structure, utilities must be disconnected and the structure must be raised off its foundation to the new height. A new permanent foundation is then built, the structure is lowered onto the new foundation, and utilities are reconnected. To relocate a structure, utilities must be disconnected, raised off foundations, and moved to their new location. Structures are then placed on their new foundations and utilities are reconnected.	Moderate to high initial costs, depending on the number of structures that require floodproofing, raising, or relocating. Low annual costs. Relocation would eliminate the need for flood-related repairs.	None	This action would be easy to implement for a small number of structures.	X	X	X	X	X	X	X	X			X													

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FM-10	Improve awareness of floodplain function through outreach and education.	It is important for the general public to understand the benefits of natural floodplain function and why keeping floodplains functioning properly is important. Development in the floodplain impedes natural floodplain function.	The general public should have an understanding of the importance of natural floodplain function and should be able make decisions on land use and development accordingly.	Increase public awareness of floodplain values and its multiple uses, including ecosystem functions, agriculture, and recreation. Conduct outreach activities using already established media outlets, such as newspapers, news broadcasts, social media. Students of all ages could be educated about floodplain values as a part of their curriculum. Opportunities exist for coordinating and sharing knowledge between State and local flood managers, and academia on best management practices, as well as new science to support adaptive management.	Low initial costs. Policy and outreach management actions will tend to have a substantially lower capital cost than other management actions that involve construction. Examples of initial costs include funding for training, education, and promoting awareness of floodplain benefits among the public and those responsible for implementing floodplain management decisions. Low to moderate annual costs, depending on how often floodplain information is disseminated.	No direct effects; however, a well informed public is more likely to support land use decisions consistent with floodplain function.	Improving and promoting flood education and awareness programs in communities could discourage communities from developing in floodplains. Often, the general public and politicians are not aware of the benefits of floodplain function and are concerned only about flooding events.	X	X	X	X	X	X	X	X		X								X							
FM-11	Examine potential interaction between natural hazards in assessing the flood risks of a community.	Some natural hazards interact with each other causing hazards that are greater than the sum of their parts. For example, wildfires can increase the extent of storm runoff during a flood and result in the movement of post-fire debris flows within a watershed.	Land use planning and decision-making should be based on a more accurate assessment of flood risk from multiple hazards.	Land use planning and decision-making would integrate the consideration of flood hazards with other hazards, such as surface fault rupture, seismic shaking, landslides, naturally occurring hazardous minerals and hazardous materials, wildfires, and post-fire debris flows.	Would increase costs of flood risk assessment	None	Would require a significant shift in land use planning and decision-making that would require political support, training, and education.				X						X												
FM-12	Establish a tsunami hazard zone with consistent requirements under local, State, and Federal agencies.	Knowledge of the behavior of major tsunami sources of greatest concern in California and the hazards they present is only recently emerging. Coastal floodplain management efforts for tsunami hazard mitigation are being conducted in disparate efforts at the Federal, State and local levels.	A hazard zone should identify the areas with greatest tsunami flooding risks.	Establishing a commonly agreed upon tsunamis hazard zone that can unify requirements under FEMA NFIP, the California Coastal Commission, and local zoning ordinances and codes for regulating development would help establish a consistent framework for implementation. Signs identifying the Tsunami Hazard Zones and Evacuation Routes could be deployed to inform the public of these areas.	Government funding would be needed to support coordination and development of a Tsunami Flood Hazard Zone.	None	Would require significant coordination across local, State, and Federal agencies.						X				X												

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FM-13	Construct new or enlarge existing transitory floodplain storage.	Insufficient flood management storage available to manage downstream flooding.	Reduce or attenuate flood peaks by increasing available transitory flood management storage.	Transitory storage occurs when peak flows in a river are diverted to adjacent off-stream storage areas. Once flow in the river decreases, water in the transitory storage area may flow or be pumped back into the river channel. Enlargement of existing transitory storage areas may involve new or modified outfall structures and weirs, or modifications to berms or training dikes to increase available storage area. New transitory storage areas could be attained by natural means or could be engineered using weirs and bypasses, or by converting existing land use to serve as transitory storage.	Medium to high initial costs, depending on location and extent of required modifications or construction. Cost factors include real estate acquisitions, relocations, mitigation costs, and complexity of any structural modifications. There is potential for a small increase in O&M costs.	Could help rehabilitate physical processes and ecological functions if transitory storage is located in historical floodplains or flood basins. Potentially extensive or complex permitting.	Institutional, funding, and political challenges exist, but generally fewer than other types of new on-or off-stream storage. Neighborhood and community opposition could be substantial in urban settings.	X	X							X			X	X	X	X		X			X			
FM-14	Increase on-stream flood storage capacity by building new storage facilities or updating, modifying or replacing existing flood storage facilities.	There is insufficient flood management storage available in some existing flood management reservoirs to regulate flood flows. New storage facilities would provide additional flood management storage. Certain existing dams may have been built to different standards and sizes or for different purposes than those required today, or they may be aging to the point that O&M and safety considerations suggest retrofit or replacement. Replacement or retrofit of an existing dam can provide increased safety, flood management and/or water supply storage, and operational flexibility.	Increase public safety, flood management and/or water supply storage, and systemwide operational flexibility by constructing a new on-stream reservoir or modifying or replacing existing storage facilities. Modifying or retrofitting a dam could reduce the possibility of dam failure during storm events.	Constructing a new flood management reservoir would provide additional flood storage to allow better management of flood flows, which would decrease the probability of releasing damaging flows downstream. The new reservoir could be designed to provide multipurpose benefits, as applicable. Replacing a dam could be done by constructing a new dam either upstream or downstream from the existing dam, and then decommissioning or removing the old dam when the new one is completed. Retrofitting a dam could include a new spillway or could raise the top of the dam to increase storage capacity.	High initial costs exist, depending on location and size of storage. Cost factors include real estate acquisitions, relocations, mitigation costs, and complexity of dam facilities. New storage would result in increased O&M costs. Modifying or replacing storage facilities might reduce O&M costs.	Substantial impacts to aquatic and riparian habitat. Increasing storage would alter upland habitat and physical processes. Extensive, complex permitting required.	Significant institutional, funding, and political challenges exist.	X	X					X		X			X		X					X	X	X			

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FM-15	Restore storage in existing reservoirs via dredging activities.	Due to location and/or watershed characteristics, many reservoirs have reduced capacity resulting from sediment accumulation within the reservoir.	Increase available flood management storage allocation in existing reservoirs.	Lost flood management storage could be restored in an existing reservoir by dredging accumulated sediments; this dredged material could be used elsewhere in the system for flood maintenance activities.	Moderate initial costs depending on location and extent of dredging and availability of disposal sites.	Moderate to substantial temporary impacts to reservoir aquatic habitat and associated species, moderate alteration of downstream physical processes. Substantial permitting requirements.	Significant institutional, funding, and political challenges exist.	X	X							X			X		X				X	X	X	X			
FM-16	Increase flood control allocation by expanding existing, on-stream reservoirs.	There is insufficient flood management storage available in some existing flood management reservoirs to adequately regulate flood flows.	Increase available flood management storage allocation in existing reservoirs.	Raising an existing dam, and thereby enlarging the existing flood management reservoir, could provide additional flood storage allocation while at the same time maintaining or increasing conservation storage. Increasing flood management storage allocation in an existing reservoir usually comes at the expense of conservation storage, except when the existing dam is raised to increase the total storage behind the dam.	High initial costs exist, depending on location and size. (Cost factors include real estate acquisitions, relocations, mitigations cost, and complexity of structural modifications to existing dam facilities). Little to no change in annual O&M costs.	Permanent impacts to aquatic and riparian habitat in the reservoir inundation area and moderate to substantial alteration of physical processes. Extensive and complex permitting.	Significant funding, institutional, and political challenges	X	X							X			X		X					X	X	X			
FM-17	Increase foothill and upper watershed storage.	There is insufficient flood management storage available in some existing flood management reservoirs to regulate flood flows. The flood management allocation space requirements drive mandated releases during the flood season to maintain flood storage within the operational flood encroachment curve (Hegedus and Shibatani, *Integrating Flood Control and Water Storage Development in the Face of Anticipated Climate Forcings*, 2009). The availability of additional flood storage in upper watershed reservoirs could reduce the required flood storage in the foothill flood management reservoirs.	Increase available storage in upper watershed reservoirs, upstream from flood management reservoirs.	When storage is available in reservoirs upstream from a flood management reservoir during flood season, that storage can often be counted as available flood storage. Although upstream reservoirs cannot be operated for flood management, incidentally available storage in existing upper watershed reservoirs could be increased by allowing surcharging of the spillways, which could increase the storage in the reservoir prior to spills.	Moderate to high initial investment, depending on location and extent of spillway modifications. Cost factors include real estate acquisitions, relocations, mitigation costs, and complexity of structural modifications to existing dam facilities. Little to no change in annual O&M costs.	Moderate to substantial temporary or permanent impacts. Potentially significant changes in physical processes. Extensive and complex permitting.	Institutional and political challenges	X	X							X			X		X					X	X	X			

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FM-18	Increase flood control allocation by using spillway surcharge.	There is insufficient flood management storage available in some existing flood management reservoirs to regulate flood flows. From a flood management perspective, maintaining sufficient flood reservation space within reservoirs could become critical during the rainy season. The deep empty space requirements often drive mandated releases during the flood season to maintain flood storage within the operational flood encroachment curve (Hegedus and Shibatani, *Integrating Flood Control and Water Storage Development in the Face of Anticipated Climate Forcings*, 2009).	Increase storage in foothill flood management reservoirs.	It may be possible to increase the available storage in existing flood management reservoirs by allowing surcharging of the spillways, which could increase the storage in the reservoir prior to spills. The use of surcharging is dependent on the design of the dam and spillway, but if it does not reduce the safety of the dam, surcharging could be achieved through modified operations of gated spillways and the use of temporary or permanent flashboards on top of ungated, auxiliary spillways.	Moderate to high initial investment costs, depending on location and extent of spillway modifications. Cost factors include real estate acquisitions, relocations, mitigation costs, and complexity of structural modifications to existing dam facilities. Increased annual O&M costs.	Moderate to substantial temporary or permanent impacts. Potentially significant changes in physical processes. Extensive and complex permitting.	Institutional, funding, and political challenges still exist.	X	X							X			X		X					X	X	X			
FM-19	Increase flood control allocation by expanding existing or building new off-stream storage.	Some existing flood management reservoirs have insufficient storage available to regulate flood flows.	Increase available flood management storage allocation in existing reservoirs.	Construct a new off-stream storage reservoir and necessary conveyance facilities. This reservoir would likely need to be built relatively close to the existing reservoir so that water could be transferred easily from the flood management reservoir to the off-stream reservoir. Prior to and during flood season, the availability of storage in the off-stream reservoir could allow water to be diverted from the conservation pool in the flood management reservoir to the off-stream storage reservoir. This would increase the flood management storage in the flood management reservoir while at the same time saving the water diverted from the conservation pool into the off-stream reservoir to be used to replace or augment regular water supply releases later in the year.	High initial costs, depending on location and size. Cost factors include real estate acquisitions, relocations, mitigations cost, and complexity and size of required dam and conveyance facilities. Additional annual O&M costs and pumping costs.	Substantial permanent impacts to terrestrial and potential wetland habitat, and moderate to substantial alteration of physical processes. Potential impacts to cold-water pool if on-stream reservoir does not fill due to drawdown. Extensive and complex permitting.	Institutional, funding, and political challenges exist.	X	X							X			X		X					X	X	X			

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FM-20	Establish partnerships to coordinate flood management structure operations.	The operations of flood management facilities are not always coordinated between regions or agencies and do not necessarily serve multiple uses.	Enhance coordination and modify operation of existing structures to provide better management of floods while serving multiple uses of the system.	Use new and existing partnerships to coordinate flood management structure operations. Operations of all facilities should be coordinated to reduce downstream impacts and serve multiple uses within the system. Coordinated operation might, in some instances, require modifications to existing reservoir management strategies, as well as to institutional and funding arrangements.	Relatively low expected initial costs and potential for reduced channel annual O&M costs. May incur costs in reduced water supply benefits.	Minimal environmental impact. Federal Energy Regulatory Commission (FERC) relicensing considerations for certain facilities, potentially significant California Environmental Quality Act (CEQA) / National Environmental Policy Act (NEPA) requirements.	Institutional, legal, and political challenges exist.	X	X							X			X		X					X	X			X
FM-21	Increase management flexibility through modifications to the magnitude and timing of flood reservations in reservoirs.	Reservoir operations conducted by many Federal, State, and local agencies are largely governed by water control manuals specific to each reservoir. These water control manuals guide operational decisions on the timing and amount of flood space throughout the year and establish objective releases. Operational constraints imposed by manuals could make systemwide, multipurpose coordinated operations and goals difficult to accomplish.	Provide better utilization of existing flood management and conservation storage for flood management.	Explore how changes to the flood reserve space can improve flood management flexibility. Modifications to reservoir rule curves could be made to specify additional downstream control points and require the coordination with operations of other reservoirs.	Low initial costs and little or no change to annual O&M costs. Changed operation could incur water supply costs.	Reservoir operations could be beneficial to restoring fluvial geomorphic processes needed by certain species.	Modifying reservoir control manuals for flood management reservoirs would be difficult and require congressional approval, but approval might not be required in all instances. Institutional, funding, and political challenges exist.	X	X							X			X		X	X		X	X	X	X	X		X	
FM-22	Increase flood management flexibility through modifications to objective release schedules at flood management reservoirs.	Reservoir operations are largely governed by water control manuals specific to each reservoir. These water control manuals guide the timing and amount of flood space throughout the year and establish objective releases (maximum controlled release that can be safely conveyed by downstream channels). Many downstream levee and diversion systems would not be capable of containing the combined objective releases of upstream reservoirs.	Provide better utilization of existing flood management along with conservation storage for flood management and protection of downstream lands and facilities.	Objective release schedules should be reviewed and revised, if needed, based on recent data and current watershed conditions. Modifications to increase objective releases could provide more flexibility and safety systemwide and potentially decrease the rate and quantity of required reservoir flood allocation, or could reduce the flood allocation for the same level of protection. Decreasing the objective release would have the opposite effect.	Low initial costs and little or no change to annual O&M costs. Changed operation could incur water supply costs.	Potential for moderate alteration of physical processes.	Modifying reservoir control manuals for flood management reservoirs would be difficult and might require congressional approval, but which might not be required in all instances. Institutional, funding, and political challenges exist.	X	X							X			X		X	X		X	X	X	X	X		X	

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FM-23	Increase flood management flexibility by implementing conjunctive use programs at flood management reservoirs.	Maintaining sufficient flood reservation space within reservoirs becomes critical during the rainy season, and maintaining that space results in mandated releases from storage during the flood season (Hegedus and Shibatani, *Integrating Flood Control and Water Storage Development in the Face of Anticipated Climate Forcings*, 2009). Conjunctive use projects might be able to use a portion of these mandated releases for groundwater recharge, where feasible.	Reduce flood risk and enhance water supply security by expanding the management tools and methods available for both flood and water supply.	Adding flood management storage allocation in an existing multiple-benefit reservoir frequently results in a conflict with water supply storage allocation. If no changes are made to the reservoir, any increase in flood storage allocation results in a decrease in conservation storage. This conflict might be alleviated by pre-storing the water supply allocation in a groundwater bank through conjunctive use operations.	Moderate initial costs, depending on location and extent of facilities. Annual O&M costs would likely increase significantly resulting from O&M for new conjunctive use facilities.	Moderate to substantial permanent impacts to terrestrial, agricultural, and potential seasonal wetland habitats. Extensive and complex permitting required, including water rights permits.	Institutional, funding, and political challenges exist.	X	X							X			X	X	X						X	X			
FM-24	Implement advanced weather-forecast-based operations to increase reservoir management flexibility.	During the flood season, reservoir operators currently follow the Water Control Manual and corresponding Flood Control Diagram developed by USACE for its reservoir operations. Most of the flood control diagrams do not provide the operational flexibility needed to improve both flood protection and water supply. Flood control diagrams do not take advantage of the most recent advancements in weather and river forecasting or in data gathering and exchange to minimize the downstream impacts of reservoir releases.	Forecast-based operations provide operational flexibility depending on snow accumulations in the basin, basin wetness, runoff forecasts, quantitative precipitation forecasts, and climate change. Forecast-based operations would provide operators information on future reservoir inflows and would allow them to better save the flood management storage for the peak of the storm to help minimize the risk of exceeding river channel capacity. Knowledge of future flows and reservoir releases would increase the warning times to communities along the rivers and downstream of flood control reservoirs.	Implementation would require developing weather forecasting and hydrologic models, as well as coordinating with reservoir operators. Implementation could require updating existing forecasting technologies.	Low to moderate initial costs, depending on whether forecasting technology (such as radars) needed to be updated. Primary initial costs consist of developing weather forecasting and hydrologic models, and establishing coordination with reservoir operators. Increased annual O&M costs if implementation includes updating the stream gauge network or other forecasting technologies. Potential for increased O&M costs due to more frequent field crew deployment. Long-term flood system maintenance costs would decrease due to improved operations from flood forecasting. Reservoir operation costs would increase due to flood forecasting efforts and increased coordination with operators.	None	Forecast-coordinated operations have proven to be politically and institutionally acceptable in some instances. However, forecast-based operations might face some political and institutional resistance because they could create binding rules that would restrict the flexibility of individual reservoir operators.	X	X							X			X		X	X						X	X			X

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Natural Floodplain Function Restoration																														
E-1	Manage runoff through watershed management.	Runoff from watershed source areas increases, in varying extents, due to increases in impermeable surfaces in developed areas, soil compaction from agriculture, reductions in vegetative cover, incision of stream channels, and losses of wetlands. Runoff flood events will worsen in the next 50 to 100 years, as regional temperatures rise and as winter precipitation falls more frequently as rain, rather than snow. The increased intensity and frequency of winter flooding might overwhelm existing flood management systems on a more regular basis, unless other efforts are taken.	Improved watershed management to enhance ecosystem function and attenuate downstream runoff, reduce the rate and magnitude of runoff during precipitation events, and lessen the need to store runoff in large reservoirs. Other desired outcomes of upper watershed management include restoration of natural communities and wetlands, additional water storage, improved water quality, and increased flexibility for water management.	Update relevant land use plans in upper watersheds to protect and increase the area of wetlands; pass legislation governing standards for subdivisions. Plans should be updated to increase vegetative cover, expand wetland areas, restore meadows, install drywells to convert surface runoff to groundwater recharge, restore natural drainages, and minimize the area of compacted or impermeable surfaces. This will increase percolation and water retention rates across broader areas and reduce the need for more expensive downstream options.	Relatively high initial costs depending on the extent of physical construction. Costs for setback levees, groundwater recharge areas, drywells, wetland creation, and right-of-way easements can be high. Reduced annual costs for O&M, repair, mitigation and other permitting requirements in the long term.	Would rehabilitate key hydrologic processes in downstream areas. Physical construction of wetland areas, drywells, setback levees, and drainage conveyance could have some adverse environmental impacts too. Minor to substantial permitting required, depending on the project.	Local implementation might face challenges because implementation would restrict development. Institutional, legal, and funding challenges exist.	X	X						X	X	X		X	X		X		X			X				
E-2	Remove unnatural hard points within and along channels.	Unnatural hard points in or on the banks of streams (such as bridge abutments, rock revetment, dikes, limitations on channel boundaries, or other physical encroachments into a channel or waterway) can affect the hydraulics of river channels, constraining dynamic natural fluvial geomorphologic processes of erosion, deposition, and channel meander that contribute to healthy and sustainable ecosystems.	Promote natural physical processes that support essential ecosystem functions within the flood management system.	Changing the physical features of the conveyance system by removing hard points, such as rock revetment, dikes, or other structures in the stream, can improve ecosystem functions by promoting natural erosion and deposition processes, aquatic and terrestrial habitat heterogeneity, and successional habitat development. However, removing hard points should be commensurate with replacement of a feature that affords a similar function (e.g., level of protection, water management, vehicular passage), and must not restrict operability or maintainability of the flood protection works.	Medium to high initial costs, depending on number, location, and types of hard points and treatments implemented. Could potentially increase or decrease annual O&M costs.	Reducing flow constrictions and hard points would rehabilitate physical processes, including sediment transport and channel-forming processes. Potential construction impacts (temporary or permanent) would be associated with physical removal of hard points. Substantial permitting would be required.	Removal of hard points has been advocated by local governmental bodies and landowners who share in the cost and responsibility of maintaining revetment that does not reduce flood risk. Institutional and funding challenges exist.	X	X						X					X			X		X				

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E-3	Develop hazardous waste and materials management protocols to identify, contain, and remediate potential water quality hazards within floodplains.	Flooding can impair water quality through the mobilization of hazardous materials or contaminants in floodplains. These materials or contaminants might originate from mines, feed lots, fuel tanks, septic systems, landfills, agricultural runoff, illegal dumping, or other sources. Flooding events following prolonged dry periods could result in increased water quality impacts from pollutants in the watershed being carried by the runoff. Increased runoff during the flood season that temporarily inundates floodways in areas known to have high levels of mercury (or other pollutants) could impact water quality by increasing methylmercury levels.	Protocols should be developed to manage hazardous waste and materials in the floodplain. Hazardous materials should be identified, contained and remediated, if necessary.	Coordinate with Regional Water Quality Control Boards to develop protocols outlining ways to identify, contain, and remediate potential water quality hazards prior to a flood event. A protocol should be developed to safely use, reuse, and treat sediment that is contaminated with hazardous materials. Additional research would need to be conducted to identify potential water quality hazards. Containment and remediation would be dependent upon the type and location of hazards found	Policy management actions would have a substantially lower initial cost than other management actions that involve structural modifications. No significant change in annual O&M costs.	Would indirectly contribute to rehabilitation of key physical processes and ecological functions by developing protocols for known highly contaminated areas and cleaning up those areas.	Existing programs to reduce contaminant loading to rivers have publicized this issue, improving its probability of political and institutional acceptance. However, there is potential for political concerns if protocols affect existing industries operating on floodplains.	X	X	X	X	X	X	X	X	X			X			X				X	X			X	
E-4	Operate reservoirs with flood reservation space to more closely approximate natural flow regimes.	Reservoir operators manage storage and releases for many competing uses. By altering flow regimes, the same dam that attenuates flood peaks and protects public safety also alters downstream hydrologic processes in ways that might reduce habitat complexity, limit habitat access for aquatic and terrestrial species, alter the in-stream flow regimes necessary to sustain floodplain and riparian habitat, contribute to channel aggradation, and contribute to the establishment of invasive species.	Re-operate reservoirs on a seasonal basis to support ecosystem needs while protecting water supplies and allowing adequate reservoir storage space for flood management. Consider State and Federal recovery goals for fish species in reoperation.	Determine ways in which ecosystem processes can be better supported by nonemergency reservoir operations, while still managing storage space for necessary water supply and flood management purposes. Releases should optimize duration, timing magnitude, and frequency of flows needed to sustain viable ecosystems and the inundation of floodplain habitat. Channel maintenance might benefit from flushing flows, which could assist with vegetation management and snag removal, while serving ecosystem needs.	Highly variable initial costs. Could result in initial costs associated with modifying dam outlet features or constructing auxiliary spillways. Might decrease water supply and hydropower benefits and/or increase the net annual cost to operate, maintain, and repair.	Operating reservoirs to more closely approximate natural flow regimes would rehabilitate key physical processes and ecosystem functions by reducing scour and deposition of sediment, by providing appropriate flows for fish migration, rearing and spawning, and by providing opportunities for establishment of native riparian tree species. Permits for reoperation would be substantial because permitting with FERC would be required.	Might face political and institutional opposition because existing release patterns provide hydropower and water supply benefits to current users of the system. Re-operation would need to show that it will not hydraulically impact the flood flow regime or increase risks.	X	X							X						X		X	X	X	X				

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E-5	Reduce the incidence of invasive species in flood management systems.	The past and continuing introduction of aquatic, riparian, and upland invasive species can reduce the effectiveness of flood facilities by decreasing the channel capacity, increasing rate of sedimentation, and increasing maintenance costs. Non-native, invasive plant species often out-compete native plants for light, space, and nutrients, further degrading habitat quality for native fish and wildlife. Introductions of non-native and invasive species have contributed to a decline in the number and function of native wildlife and plant communities (Cohen and Carlton, *Accelerating Invasion Rate in a Highly Invaded Estuary*, 1998).	Effective control of species. Cost-savings and increased success from using a systemwide approach to invasive control. Updated regulations to use natives for revegetation efforts and remove uses of non-natives. Institution of best management practices for treatment and control of widespread non-native invasive plant species.	Define and prioritize by potential threat impacts of non-native species and invasive species that are potentially detrimental to recovery of native species. Coordinate regional approaches to control of invasive species. Initiate non-native plant species mapping within and adjacent to water channels. Use only native species for restoration projects in revegetation projects and hydroseeding, and use approved weed-free materials for erosion control. Revise and update regulatory standards to prohibit introduction of non-native species in flood management systems.	Medium initial cost. Lower cost relative to structural improvements, but potential costs related to permitting, maintenance, mapping, and technical evaluation on how to control invasive species. Increase in the annual maintenance costs to control the spread of invasive species, but over the long term, invasive removal could result in annual cost savings.	Reducing the spread of invasive plants would rehabilitate key physical processes and key ecosystem functions, because some invasive plants obstruct flow and sediment transport, cause excessive channel and bank erosion, compete with native vegetation for light, water, and nutrients, and provide no or less habitat value for native wildlife species.	Likely to be politically and institutionally acceptable.	X	X	X	X	X	X	X	X							X	X	X	X	X	X				
E-6	Remove barriers to fish passage.	Construction of major dams that are part of the flood, hydropower, and water supply systems in California have had a major impact to California's native anadromous fish populations. Historical spawning and rearing habitats have been made inaccessible to fish. Many dams were built without legally mandated fish passage facilities under the California Department of Fish and Wildlife (CDFW) code of regulations, and hatcheries were supposed to offset the impact.	Reduce the number of physical barriers to fish passage without impacting the ability to ensure public safety or limiting other water management strategies. This includes providing fish passage past the major rim dams to provide access to remaining cold water spawning and rearing habitats upstream in the higher elevation watersheds, and includes other barriers in the system such as water diversions and culverts.	Identify physical barriers that inhibit fish passage. Evaluate opportunities for enhancing fish passage through existing obstructions, including installation of fish ladders or removal of the barrier. Coordinate with existing State and Federal fish passage removal programs. Implement feasibility studies to assess and test ladder options, as well as other ideas for passage around dams.	Medium to high initial costs. Removal or modification of fish passage barriers and construction or reoperation of alternative water management facilities and strategies for deliveries and usage would have high initial costs. The removal of some barrier structures would be unlikely to change annual costs to operate, maintain, or repair.	Removing fish migration barriers would rehabilitate key ecological functions by enhancing salmonid migration and access to spawning habitat. Substantial, but less complex, permitting requirements.	Removal or modification of smaller fish passage barriers would likely to be more politically and institutionally acceptable than removal of larger barriers such as large flood control and water supply dams and weirs, which might face stronger political and institutional resistance. Institutional, legal, and funding challenges exist.	X	X									X			X				X	X				

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E-7	Set back levees that connect rivers to floodplains.	Levees constructed immediately adjacent to streams, as well as continual bank protection and channel stabilization, not only reduce floodplain storage capacity resulting in more downstream flooding, but can also severely modify natural geomorphic processes such as erosion, deposition, and channel meandering. Levees limit the area available for riparian forest development resulting in loss of riparian habitat and associated terrestrial species, shaded riverine habitat, and large woody debris; levees reduce groundwater recharge, and limit insect availability for foraging fish.	Expand the footprint of the flood system to reconnect floodplains, increase detention, attenuate flood flows, reduce downstream flood risks, minimize O&M costs, and restore critical habitats.	Identify areas where levees could feasibly be breached or set back from the existing low-flow channels. Leverage existing knowledge and ongoing projects to identify opportunities for setting back levees.	High initial costs. Setting back levees might have significant capital cost associated with land acquisition and physical construction. Would likely decrease the annual cost to operate, maintain, and repair by reducing stress on levees and attenuating flood flows.	Would rehabilitate key physical processes by reconnecting channels to historical floodplains and enhancing sediment transport, channel- and floodplain-forming processes, groundwater recharge. Would improve water quality and rehabilitate ecological functions by increasing riparian and wetland habitat area, quality diversity, and connectivity, and by increasing spawning habitat and salmonid rearing habitat. Could result in moderate to substantial permanent impacts to terrestrial and agricultural habitats, and potentially to canal or seasonal wetland habitats.	Political and institutional acceptability is likely to depend on local jurisdictions. Might be a good opportunity for rural areas to obtain adequate flood control. Institutional, funding, and community relations challenges exist.	X	X							X		X	X	X	X	X		X	X	X	X			X	

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E-8	Restore channel alignment (i.e., conduct de-channel-ization).	In many areas, channels have been straightened to increase the capacity and flows. Straightening of channels has eliminated adjacent habitat and often requires hardened structures to protect the bed and banks of the channel, thus further eliminating habitat.	Restored alignment of channels that have been straightened to increase natural meanders and lateral bed and bank of the channel. De-channelization would be accomplished without sacrificing the sustainable operability and maintenance of the flood protection works or increasing the flood risk.	Identify and evaluate sites where de-channelization might be feasible. De-channelization will provide additional flood storage capacity. This action is a proactive attempt to restore channel alignments that have been straightened (channelized).	Medium to high initial costs, based on size of project, real estate acquisitions, relocations, costs for permitting, design, construction, mitigation, and loss of property taxes. Increased short-term annual costs and decreased long-term annual costs. O&M costs might increase during the establishment period. Once a channel is restored, costs could decrease overall because a meandering channel could attenuate flood peaks.	De-channelization would rehabilitate key physical processes and ecological functions of the channel. This in turn would benefit multiple native riparian vegetation and wildlife species, including special-status species. Construction activities and grading associated with this management action could have minor to moderate temporary impacts (and potentially permanent impacts). However, these impacts might be offset by the benefits associated with de-channelization. Could reduce permitting related to O&M practices over time.	Typically, de-channelization requires an increased footprint to provide the channel room to meander. Thus, any de-channelization must consider potential conflicts with existing urban and agricultural uses, local zoning regulations, local economies, private property rights, and water rights. Might be mostly applicable to smaller tributary streams. Another potential implementation challenge is defining responsibilities for long-term maintenance of restored habitat. Additionally, habitat creation projects have to compete for scarce financial resources, so implementation might be slow due to tight budgets.	X	X							X			X	X		X		X	X	X	X			X	

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E-9	Encourage natural physical geomorphic processes, including channel migration and sediment transport.	Natural channel processes, such as erosion, deposition, channel migration, formation of natural channel features (e.g., point bars, oxbow lakes), and sediment transport have been restricted by various flood management projects, as well as O&M.	A comprehensive approach to emphasize and prioritize projects and other actions that encourage natural physical processes.	Identify areas that might be suitable for restoration of natural physical geomorphic processes. Consider systemwide physical processes when proposing new projects, including levee strengthening and repairs, bank erosion control, setback levees, dredging, gravel augmentation, channel alignment restoration, and large-scale vegetation planting and removal.	Medium to high initial costs, based on size of project, real estate acquisitions, relocations, costs for permitting, design, construction, and mitigation, as well as loss of property taxes. Increased short-term annual costs and decreased long-term annual costs. O&M costs might increase during the establishment period. Once a channel is restored, costs could decrease overall because a meandering channel could attenuate flood peaks.	Would result in restoration of physical processes and improvements to ecological functions of the channel. This in turn would benefit multiple native riparian vegetation and aquatic and terrestrial wildlife species, including special-status species. Likely minor to moderate, temporary impacts and potentially permanent impacts. However, these impacts might be offset by the benefits associated with habitat creation and restoration. Permitting required varies, depending on the size of the project.	Potential implementation challenges related to changes in existing and potential future land uses and land acquisition. Institutional, funding, and community relations challenges exist.	X	X	X						X			X	X		X		X	X	X	X			X	

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E-10	Improve the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.	Significant loss, fragmentation, and degradation of native habitat types have occurred within flood management systems and their associated floodplains.	Habitats would be established without sacrificing the sustainable operability and maintenance of flood protection works or increasing the flood risk. Increased riparian forest restoration, leading to greater carbon sequestration and reducing our impact on global climate change.	Identify and evaluate areas to increase the quality, quantity, and/or diversity of wetland, riparian, and/or other native habitat. Identify effective approaches to improve habitat and ecosystem processes that also benefit a variety of important species. Identify candidate areas that are most suitable for restoring habitat while meeting other benefits. Habitat enhancement and creation could be considered on a regional basis (i.e., through establishment of a mitigation bank).	Highly variable initial costs, depending on the type of effort. Cost factors include real estate acquisitions, relocations, permitting, design, and construction, as well as potential loss of property taxes. Annual costs would increase in the short term, but should decrease over the long term. Increased monitoring and maintenance of restored wetlands might moderately increase the annual cost for O&M, especially during the establishment period. Increased bank stability, reduced erosion rates, attenuation of flood peaks, and reduced sediment deposited downstream could all reduce annual O&M and repair costs.	Would increase the quality, quantity, and diversity of native habitat types within the flood system and could rehabilitate key physical processes and ecological functions. The restoration of these habitat types would benefit multiple native riparian vegetation and wildlife species, including special-status species. Likely minor to moderate, temporary impacts and potentially permanent impacts. However, these impacts might be offset by the benefits associated with habitat creation or restoration. Possibility of mercury methylation, depending on the location and type of wetland creation. Permitting requirements vary, depending on the extent and nature of habitat projects.	Likely to be politically and institutionally acceptable, especially in areas that would not require extensive modification to flood infrastructure. Habitat creation projects have to compete for scarce financial resources, so implementation might be slow due to tight budgets. Habitat restoration and creation must consider potential conflicts with existing urban and agricultural uses, local zoning regulations, local economies, private property rights, water rights, and responsibilities for long-term maintenance of restored habitat. Institutional, legal, funding, and community relations challenges exist.	X	X	X	X	X	X	X	X				X			X	X	X	X	X	X			X	

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Permitting																														
P-1	Develop regional and corridor conservation plans, or expand existing regional conservation plans (such as regional HCPs and NCCPs) to provide a more efficient and effective regulatory approval process for flood projects.	Habitat and ecosystem planning currently is conducted in piecemeal, fragmented fashion in many areas. Multiple regulatory agencies are responsible for ensuring the protection or mitigation of environmental resources impacted by flood management activities. Limited coordination and shared vision result in a regulatory approval process that adds complexity and scheduling challenges to flood project approvals. It also results in fragmented conservation projects that might have limited viability in terms of long-term biological success.	High-quality regional and river-corridor conservation plans that both improve the success rate of flood project regulatory approval and provide improved multi-species habitat that is viable for the long term.	Develop plans such that they provide measurable biological objectives for targeted resources, incorporate adaptive management approaches, fund long-term habitat management and monitoring, and provide the public with the opportunity to assess, review, and critique plans as they are being developed.	Medium to high initial costs. Plans such as HCPs and NCCPs require adequate funding to develop. Implementation of the plans would have varying capital costs. Changes to annual costs.	Increased regional collaboration among habitat and ecosystem planning and mitigation would result in rehabilitation of ecosystem functions by concentrating mitigation in larger areas, and by selecting more suitable lands for mitigation than is possible with piecemeal mitigation. Would result in improved and streamlined permitting for future projects. Impacts associated with flood system O&M could be reduced because O&M would be better facilitated and mitigation better coordinated.	California currently already has more than 30 regional conservation plans in varying stages, with some plans in the implementation phase for more than 10 years. Corridor management plans are already under development, and they are being viewed as valuable approaches for meeting multiple flood management goals on specific reaches. Institutional, legal, and funding challenges exist.	X	X	X	X	X	X	X	X			X		X		X	X	X	X		X			X	X
P-2	Develop regional advanced mitigation strategies and promote networks of both public and private mitigation banks to meet the needs of flood and other public infrastructure projects.	Some flood management projects require offsite mitigation to compensate for habitat losses. Identifying suitable offsite locations is often left to the last phase of flood projects, as the extent and nature of the expected impacts become more evident. Regulatory agencies need to approve these offsite locations, and negotiations can delay overall flood project approvals. Second, a temporal loss of habitat occurs between the time when the flood project removes habitat and when compensatory habitat is restored to pre-project levels. Third, offsite locations that are comparable in area to the impact are often too small and isolated to have long-term viability and often require high maintenance costs. Lastly, generating funding sources for mitigation early in the planning stages is an obstacle.	High-quality regional advance mitigation strategies and networks of mitigation banks that meet the needs of flood management and other public infrastructure projects.	Develop supporting policies, sustainable funding sources and partnerships with regulatory agencies for planning and implementation of comprehensive regional advance mitigation banks.	High initial cost. Establishment of mitigation banks requires acquisition of land, permitting, restoration, and funding for long-term management and monitoring. Regional collaboration for advance mitigation banks is likely to decrease overall costs of regulatory compliance and mitigation for O&M and repair activities. Potential exists to leverage private conservation funds.	Implementation and coordination on regional advance mitigation planning would result in rehabilitation of ecosystem functions by concentrating mitigation in larger areas, by implementing mitigation in advance of impacts, and by selecting more suitable lands for mitigation than is possible with piecemeal mitigation. Improved and streamlined permitting would be needed for future infrastructure projects. Banking has a complex set of permitting requirements, and it will take extensive work to create credits that can be used for flood projects.	There is high interest in developing regional advance mitigation banks from infrastructure agencies, resource agencies, and conservation organizations. Private mitigation banks already exist, and regulatory agencies have developed standard approval processes for establishing these banks. Institutional, legal, funding, and community relations challenges exist.	X	X	X	X	X	X	X	X			X				X	X	X	X	X	X			X	X

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P-3	Develop proactive integrated regulatory compliance strategies that streamline permitting activities.	Numerous permits are required to conduct routine maintenance, restoration, enhancement, and other activities. Challenges associated with permitting include the costs associated with documentation and mitigation, length of the process, restrictive conditions, conflicting State and Federal priorities, limited construction work windows, uncertainty regarding which permits are required for routine maintenance, and limited coordination among the various entities issuing permits. Many maintaining agencies have expressed concern over the amount of funds dedicated to obtaining permits to perform required maintenance. This situation creates regulatory uncertainty for both the State, maintaining agencies and regulatory agencies.	Implement a regulatory compliance strategy (such as the DWR Small Erosion Repair Program), that standardizes and streamlines the permitting process (timeliness and efficiency), reduces costs, and promotes regional efforts that support more successful mitigation to improve public safety, reliable water supply, and ecosystem function.	Identify where environmental clearance and permitting processes can be made more efficient while still meeting State and Federal safety standards and following State and Federal environmental protection procedures. Some options include: 1) Increasing the duration over which permits are valid to reduce costs and promote proactive maintenance. 2) Establishing an interagency permitting office or clearinghouse to improve the review, frequency of inspection, and enforcement of encroachment permits and permit violations. 3) Providing habitat restoration above and beyond what is necessary for project impacts could assist in streamlining future mitigation needs as would implementing a Regional Advanced Mitigation Program. Establish a consistent, widely recognized definition of "routine maintenance" and the activities associated with maintenance. Know how routine maintenance actions could avoid and minimize impacts.	Low initial cost. Policy actions will tend to have a substantially lower capital cost than actions involving physical construction. If land is purchased for mitigation, initial costs could be high. A streamlined permitting process has the potential to reduce long-term annual maintenance and repair costs by allowing more and swifter repairs where needed before sites become larger.	Implementing proactive compliance strategies could address larger scale environmental impact avoidance and opportunities to enhance the environment. It could allow for rehabilitation of ecological functions by implementing mitigation in larger consolidated areas, in advance of impacts, and in more suitable areas than with piecemeal mitigation. Impacts associated with flood system O&M could be reduced because O&M would be better facilitated and mitigation better coordinated.	Initial development of a new permitting strategy would require intense coordination and commitment by multiple agencies; however, once streamlined and/or programmatic permitting mechanisms are established, flood system maintenance activities would be more timely and cost-effective for all parties involved. A streamlined process is likely to preserve maintenance funds for the intended maintenance, not redirecting them for permitting costs. The net result is cheaper, more reliable, and better maintained flood management systems.	X	X	X	X	X	X	X	X			X				X		X			X			X			X	

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P-4	Establish memorandums of understanding (MOUs) and/or management agreements between agencies to integrate the needs to be served by flood control systems.	Some flood infrastructure is located near critical habitat and migration corridors for many listed and endangered species. There are many challenges to implement mitigation and restoration activities in support of flood infrastructure. Conducting ongoing maintenance is also a costly, complicated and lengthy process. There are few interagency collaborations and partnerships that leverage the strengths of multiple agencies and organizations to achieve successful mitigation, restoration, ongoing maintenance, and the achievement of multiple benefits.	An efficient, collaborative interagency approach, which acknowledges that the prime purpose of flood management is public safety, as well as providing the appropriate assurances and processes to allow for mitigation and restoration efforts that would be managed in concurrence with ongoing operation and maintenance for flood management and water supply.	Use approaches and interagency MOUs and management agreements, such as those used for the Yolo Basin Wetland Project, to provide the assurances and processes needed to enable mitigation and restoration opportunities to be realized, while providing for effective management of water supply, flood control, and habitat.	Low initial costs compared with structural measures. Potential to decrease annual O&M costs through streamlining and improving regional coordination.	No direct effects on environmental conditions. Improved coordination could foster integration of mitigation, restoration, and conservation activities across multiple agencies and jurisdictions, which would result in more successful rehabilitation of ecosystem functions (consolidating mitigation efforts within regions, implementing mitigation in advance of impacts, and selecting more suitable lands for mitigation). Could result in improved and streamlined permitting processes, including long-term agreements and authorizations for future efforts.	May be difficult to initially develop the MOUs. Requires up-front time and cost for pre-planning and execution of the agreements. Institutional, legal, and funding challenges exist.	X	X	X	X	X	X	X	X			X	X			X					X			X	X
P-5	Increase understanding of environmental permits.	Applying for and obtaining environmental permits for construction and O&M activities can be a complex and arduous process.	Greater understanding of what permits are required, what the agencies need to issue these permits, and the timelines associated with these permits.	Provide technical assistance and education on required environmental permits for construction and O&M activities. A permit workbook would be developed and distributed in training workshops. The workbook would include a description of the relevant permits, permit applications, and permitting guidance for each of the regulatory agencies. Applicable laws and regulations include, but are not limited to, Section 404 of the Clean Water Act (CWA), Section 10 of the Rivers and Harbors Act, Section 401 of the CWA, Sections 1602 and 1603 of the California Department of Fish and Wildlife Code, Endangered Species Act, California Endangered Species Act, California Environmental Quality Act, and Section 106 of the National Historic Preservation Act.	Low initial costs compared with structural measures. Would likely have no significant change on annual costs to operate, maintain, or repair.	Technical assistance and education on environmental permits could help facilitate the environmental permitting process and indirectly have a positive impact on physical processes and ecological functions.	Technical assistance and education on environmental permits are anticipated to be well received; therefore, the likelihood of implementation is high.	X	X	X	X	X	X	X	X			X				X		X						X	X

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P-6	Corridor Management Strategy (CMS)	Many flood infrastructure facilities encompass critical habitat and migration corridors for many listed and endangered species. Flood infrastructure in many areas is nearing the end of its design life. Many challenges exist to obtaining permits and clearances for repair, replacement, and ongoing maintenance. A new approach in managing flood control infrastructure is required if today's needs are to be served.	An effective and sustainable water management system through integration of public safety, water supply, and ecosystem function—managing flood infrastructure as a system and in a manner that addresses the needs of all three.	Identify discrete corridors; assess existing channel habitat and geomorphology to identify how the channel could be better managed in terms of public safety, water supply, and ecological function; and develop long-term management plans for these corridors, including a prioritized list of needed repairs and/or new construction; areas identified for ecosystem restoration opportunities; a long-term routine maintenance plan; permits and clearances for nearer-term repair/construction and routine maintenance (long-term); performance measures for public safety, water supply, and the ecosystem; a monitoring and reporting plan evaluating success in meeting performance measures; and an adaptive management plan. Modifications to the corridor and ongoing maintenance will be designed to manage for flow (peak for public safety, and non-peak for reliability in water supply) and improved ecosystem function. Project proponents, along with State, Federal, and local permitting agencies, local maintaining agencies, and representatives from local communities served by the corridor should all be a part of the process when Corridor Management Strategy plans are developed, so the critical needs of all entities either responsible for, or served by, the corridor could be considered in the process and appropriate solutions could designed to address the various needs, system performance criteria, and permitting requirements.	Medium initial costs. Corridor Management Strategy plans require adequate funding to develop. Implementation of the plans, which constitute other management actions, will have varying capital costs depending on the extent of real estate and construction needs. Annual O&M costs would decrease. Long-term management plans for maintenance could allow for more and swifter repairs where needed before sites become larger, which is less costly, and better for the environment and public safety.	Use of long-term plans could allow for mitigation that allows for enhancement of corridors for improved ecological functions by implementing mitigation in larger consolidated areas, in advance of impacts, and in more suitable areas than with piecemeal mitigation.	Corridor Management Strategies are being developed and they are being viewed as valuable approaches for providing multiple benefits on specific reaches, including flood management and improved ecosystem function.	X	X	X	X	X	X	X		X		X	X			X	X	X	X	X	X			X	

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Flood Emergency Management (Flood Preparedness, Response, and Recovery)																															
FP-1	Coordinate flood response planning and clarify roles and responsibilities related to flood preparedness and emergency response.	Unclear roles for local (city and county) and State agencies in supporting flood-fight operations can impede quick and effective flood fighting during a major event. Some agencies and organizations charged with responding in the field during a flood emergency lack the capacity, resources, and interagency coordination necessary to carry out these duties effectively. This is also related to limited conduct or participation in emergency response exercises between flood events. Further, there is infrequent coordination between agencies and limited ability to advance new technologies and science related to levee breaches and flood fighting.	Reduce the consequences of flooding by clarifying roles and responsibilities, improving training and the capacity of emergency response staff, and increasing coordination at all levels of government.	Includes a broad range of tactics at the State and local levels to clarify roles, increase communication, and improve the effectiveness of response to floods. These tactics could include promoting flood contingency and response planning at local and regional levels; establishing a team to review current regional and local flood emergency procedures, response capacities, and communication capabilities; and convening Maintenance System Specialist committees to review and update Flood Emergency Action Team (FEAT) guidance and recommendations. Joint field training exercises and briefings could be facilitated to test and refine response procedures, communications, and logistics, and educate response staff.	Low to medium initial cost. Policy management actions would tend to have a substantially lower capital cost than other management actions that involve physical construction. No significant change in annual costs.	None	High potential for political and public support; institutionally, support also exists, although opinions on how to implement and fund these actions likely differ. Establishing a clear and shared understanding of roles and responsibilities at all government levels might be difficult. Local agency participation might be affected by lack of funding.	X	X	X	X	X	X	X	X			X													X
FP-2	Improve communication and public awareness of emergency response procedures and terminology.	Public awareness and education prior to a flood emergency directly affects emergency response and recovery efforts. There is a need to educate the public on potential flood risks and how they should respond in a flood emergency. The public's response to any emergency is based on an understanding of the nature of the emergency, the potential hazards, the likely response of emergency services, and knowledge of what individuals and groups should do to increase their chances of survival and recovery.	Increased public awareness and understanding of community flood hazards, emergency response operations, and evacuation procedures before a flood event is imminent.	Effective hazard communication plans would be developed that use standardized evacuation terminology, and these plans would be effectively communicated to the public. Creation of simple, standardized flood threat levels that could be easily displayed on maps and used in public media advisories. Public outreach meetings to notify property owners of flood risks, safety measures, and evacuation routes. Opportunities to integrate this preparedness information into the public education curriculum.	Low initial costs. Many existing products are available for use as templates. Increased annual costs possible at the county level. Public information sources and materials, such as websites, maps, and fact sheets, might require ongoing maintenance or updating; and hazard communications plans and related materials would likely need to be reviewed annually to ensure that the information remains current and correct.	None	Politically and publicly acceptable at the State, regional, and local levels. Some smaller local governments might be limited in their funding and institutional capacity to create hazard communication plans and education outreach without additional assistance.	X	X	X	X	X	X	X	X			X													

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FP-3	Establish standard flood warning systems and procedures.	While some jurisdictions have established flood warning systems and procedures, other jurisdictions lack them completely. Additionally, a number of different warning systems are currently in varied levels of use at State, Federal, and local levels. The range of warning or alert systems could cause confusion among the public when responding to a flood emergency, could prevent warnings from reaching all members of a community, and could prevent interconnectivity between systems in use by different jurisdictions.	Increase public awareness of flood emergencies and increase time for the public to implement home and business emergency actions.	In coordination with existing systems, establish enhanced standard flood warning procedures and terminology. Implement a statewide alert and warning system that is consistent with Federal warning protocol and procedures but flexible enough to accommodate the various technologies that local jurisdictions already use to warn residents. Such a system and steps for its implementation are described in 2008 and 2009 California Emergency Management Agency (CalEMA) reports. Warning systems include outdoor sirens and reverse-911 calling systems. Systems and procedures would be incorporated into local emergency operations plans.	Low capital costs and no significant change in annual costs if implementation does not require physical upgrades or modifications of existing alert systems (such as sirens), or installation of new systems.	None	Likely to be politically acceptable at the State and local levels, particularly since this need has already been documented at the State level. Some smaller local governments might be limited in their funding and institutional capacity to adopt standard flood warning systems and procedures. Additionally, local jurisdictions might understand which systems would be most appropriate for their populations or could be resistant to this action if implementation includes adopting entirely new systems. Other challenges include "warning fatigue" from the public when confronted with another alert system and the likelihood that the public ignores warnings due to past false alarms.	X	X	X	X	X	X	X	X			X																

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FP-4	Improve stream gauge network for forecasting purposes.	Flood forecasting models are limited, in part, by the quantity and quality of available stream gauge network data.	Additional stream gauges and data sensors installed to improve the quality of flood, tsunami, and reservoir inflow forecasts. Real-time data, timely availability, and real-time data quantities and quality are all critical data input to the forecasting models and contribute to improving forecasting quality and timeliness.	Install, maintain, and provide priority funding for a comprehensive stream gauge network that would improve flood forecasting and monitoring. The network would incorporate and update existing U.S. Geological Survey (USGS) and USACE stream-gauging systems where appropriate. State, Federal, local, and other public and private entities could collect and share stream gauge data. This network would include real-time gauging and dual path telemetry for river stage, rainfall, and temperature data. Network could also be applied for tsunami and seismic sensor data.	Low initial costs. Primary initial costs would consist of installing new gauging stations. Increased annual O&M costs for the stream gauge network. Long-term flood system maintenance costs would decrease slightly due to improved operations from flood forecasting. Reservoir operation costs might increase very slightly due to flood forecasting efforts and increased coordination with operators.	Improving the stream gauge network would result in minor temporary impacts to riparian and aquatic habitat. Installation of new stream gauge stations might require potentially lengthy permitting.	Political acceptability would likely be high across all levels of government. Institutional capacity to improve flood forecasting would reside in the State and Federal levels of government.	X	X	X	X	X	X	X				X	X									X					
FP-5	Establish or improve instrumenta-tion for early warning systems for flood facilities	Warning affected citizens depends not only on knowing when a flood peak will occur and how large it will be, but also on knowing the condition of flood infrastructure protecting those citizens. Currently, a system is in place to provide accurate and frequent information on river stage at several reporting gauging stations. However, the system is not set up to provide information on the conditions of flood infrastructure.	Development of a network of telemetered sensors (piezometers and Optical-Time-Domain Reflectometry) that would provide information on seepage pressures and flood infrastructure movement for earthen flood infrastructure. Such information would be extremely useful for coordinating emergency response.	Flood forecasting and warning could be supplemented by a system of telemetered sensors (piezometers and Optical-Time-Domain Reflectometry) that would record and transmit seepage pressure and monitor movement along critical reaches of earthen flood facilities (e.g., levees, dikes). This would provide comprehensive predictions of floods and warning of flood danger from overstressed flood facilities. This system could be installed first in flood facilities protecting high-risk areas. Other instrumentation could include remote sensing technology.	Low to moderate initial costs. Primary initial costs would consist of installing new early warning instrumentation. Moderate increase in annual O&M costs related to maintaining instrumentation but potentially increased efficiency and effectiveness of future O&M because maintaining agencies would better know which flood facilities are stressed during high-water events.	Installing an early warning system could result in temporary or permanent impact to riparian and aquatic habitat, depending on site location.	Political acceptability would likely be high across all levels of government. Institutional capacity to improve early warning instrumentation would likely reside in the State and Federal levels of government.	X	X	X	X	X	X	X				X														

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FP-6	Create Emergency Action Plans (EAPs) to address dam failure.	Dams can fail due to earthquakes, extreme flooding, poor design, unsound construction, inadequate maintenance, or age-related problems. Failure could cause catastrophic flooding for downstream areas.	Thorough and consistent emergency action planning to help save lives and reduce property damage in areas that would be affected by dam failure or operation.	An EAP is a formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP specifies actions the dam owner should take to moderate or alleviate the problems at the dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. The EAP also contains inundation maps to show the emergency management authorities of the critical areas for action in case of an emergency.	Low to moderate initial costs. Initial costs are needed to develop EAPs. Annual costs consist of updating the EAP on a regular basis.	None.	Political acceptability would likely be high across all levels of government.						X				X										X			
FP-7	Protect critical infrastructure corridors from floodwaters.	The infrastructure needed to facilitate the flow of resources into, or evacuees out of, a flooded area could be impacted or incapacitated in the event of a flood. Critical infrastructure includes transportation corridors (e.g., highways, roadways), electric power supply, railroads, fuel supply lines, telecommunication systems, water supply and wastewater treatment and distribution facilities (aqueducts, pumping stations), hospitals, fire and police stations, and others. This could hinder the orderly and timely evacuation of people and animals of value, impede access by emergency response personnel, and impede restoration of lifeline utility infrastructure (e.g., water, power, sewer, and telecommunications).	Facilitate effective emergency response and recovery by protecting critical public infrastructure from floodwaters.	Methods for protecting critical infrastructure would vary, depending upon size and type of infrastructure. For example, vital transportation corridors could be protected by embankments, by flood-control berms, or by elevation above floodwaters. Additionally, alternative transportation methods and locations would be identified if primary infrastructure could not be protected. Pumping stations for sewer or water utilities could be floodproofed and equipped with onsite backup power generators. Micro and/or surveillance cameras at critical public assets could be installed. Coordination between Federal, State, and local agencies and private utilities would be needed.	High initial costs. Little or no change to annual O&M costs.	Site-specific, but potential substantial permanent impacts to terrestrial and potentially wetland and riparian habitats, including loss of habitat for special-status species. Extensive and complex permitting likely required.	Implementability would depend on size and type of infrastructure, ownership (Federal, State, local, Tribal, and private), cost, and potential construction impacts (economic, social).	X	X	X	X	X	X	X	X			X												

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FP-8	Increase financial liquidity of local agencies during flood emergencies.	Funding available to finance O&M, repairs, and flood fighting varies widely across agencies, and many have a limited ability to raise funds (particularly during emergencies). For example, flood fight responders must often seek assistance or funding for rock, supplies, and technical expertise from the next level of local, State, or Federal jurisdiction. Most available State and Federal funding sources related to floods are aimed at reducing risk and potential damages in advance of a flood or reimbursing the appropriate jurisdiction for eligible emergency response work—not at helping finance operations during flood fights.	Improved ability of local agencies to quickly raise funds when a flood or other threat to levee stability is imminent.	Several actions could facilitate financial liquidity for local agencies when a flood fight is imminent. One is creation of a public loan guarantee program that would promise to assume maintenance district debts from loans obtained to help finance flood flights in the event that districts cannot repay them immediately. This would allow even very small agencies to purchase the resources and expertise needed to help hold back floodwaters. Another option is the creation of an Emergency Fund.	Low to high initial costs to implement, depending on type and magnitude of program. Annual O&M costs would not change.	None	Potential for broad public support, particularly at local level; would require the identification of sustainable funding, which might require changes to laws and regulations governing the generation of funds for flood system maintenance and repairs. These programs might complicate local efforts to seek FEMA funding assistance after the event, and would need a repayment structure.	X	X	X	X	X	X	X	X			X													
FP-9	Improve evacuation planning.	Not all agencies have prepared local or regional flood-specific evacuation plans. Not all local jurisdictions integrate flood evacuation plans into their overall emergency plans. Not all jurisdictions have distilled flood emergency preparedness and evacuation information into succinct summaries easily accessible and understandable by the public.	Increased coordination across emergency response agencies and greater public awareness of proper evacuation procedures to reduce loss of life during severe flood events.	Coordination between State and local emergency management agencies and officials in developing or updating local flood evacuation plans that identify the range of involved agencies and personnel, notification procedures, public and private transportation options, and evacuation routes and procedures that are easily accessible and understood by the public. These plans should also consider ingress routes for flood fighters while an evacuation is in process. Important tools in this effort include the 1997 FEAT guidelines for flood emergency operations and ordering evacuations, as well as other mapping tools, vulnerability assessments, and other products from State or regional agencies that could help public safety make decisions on ordering evacuations.	Low initial costs. Policy management actions will tend to have a substantially lower capital cost than other management actions that involve physical construction. No change in annual O&M costs.	None	Likely to be politically acceptable at the State and local levels. Some smaller governments might be limited in their funding and institutional capacity to create evacuation plans without additional assistance.	X	X	X	X	X	X	X	X			X													

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FP-10	Develop post-flood recovery plans to improve the coordination and efficiency of post-flood assistance.	There is significant variability in the extent and quality of post-flood recovery planning. Where post-flood recovery plans exist, such plans are generally driven by the eligibility requirements of the Stafford Act. Debris removal and economic recovery operations are often conducted well after floods, but are often limited to the extent that the operations are eligible for limited State disaster assistance funds and/or Federal reimbursement and assistance (e.g., through FEMA, USDA). Coordinating post-flood recovery activities can be difficult because the range of agencies with legal or voluntary responsibilities for disaster recovery often crosses jurisdictions and levels of government.	Development of simple, direct, integrated plans of action for post-flood recovery to reduce confusion, clarify roles and responsibilities, and facilitate expedited disaster recovery.	Identify all responsible people, agencies, or organizations with disaster recovery roles and responsibilities; detail relevant recovery activities, including levee repair, floodwater evacuation, and property and infrastructure rehabilitation; establish or describe timelines and protocols for accomplishing recovery activities; identify all State, Federal, and non-governmental sources of potential disaster assistance funding, both general and flood-specific.	Low initial costs. Policy management actions tend to have a substantially lower capital cost than other management actions that involve physical construction. Capital investments include funding for multi-agency, multi-jurisdictional planning and development of post-flood recovery plans. Increased post-flood recovery planning prior to flood events reduces maintenance and repair costs for maintaining agencies.	None	Politically and publicly acceptable at State, regional, and local levels. Institutionally, there might be difficulties with developing a single plan for an entire region (unless there is resolution of inconsistencies related to agency responsibilities in various regions). Some smaller agencies might be limited in their funding and institutional capacity to develop post-flood recovery plans.	X	X	X	X	X	X	X	X			X												X
FP-11	Streamline the post-flood permitting process for flood system repairs.	Obtaining permits for post-flood system repairs involves coordination with multiple agencies that can exceed the staff resources and budgets of smaller maintaining agencies. With multiple permits required for most maintenance and mitigation activities, and no central location for coordinating the process, obtaining the necessary permits often takes longer than the actual repairs.	Reduced costs and time needed to complete system repairs could reduce future flood risk.	The process of obtaining permits for the repair of damaged structures would be streamlined and consolidated, to save time and money. Coordination with Federal and State agencies involved in the permitting process to develop a consistent permitting program that is easy to understand and comply with at the local level. Permit applications submitted to Federal and State agencies through the permitting program would have priority in the review process, allowing permits to be issued in a timely manner so that repairs of damaged infrastructure could begin shortly after a flood event.	Medium initial costs. While policy management actions tend to have a substantially lower capital cost than other management actions that involve physical construction, significant interagency coordination (on the State and Federal levels) is required to streamline the permitting process for repairs to flood systems. Streamlining the permitting process should reduce annual costs for maintaining agencies.	None	Streamlining the permitting process should be very popular with maintaining agencies because it would reduce the time and funding required to obtain permits. Likely to be politically and publicly acceptable. State and Federal permitting agencies might oppose this effort if it appears to render permit requirements that are less stringent or that infringe upon their authority or jurisdiction.	X	X	X	X	X	X	X	X			X												X

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FP-12	Purchase and pre-position flood-fighting materials and tools in preparation for a flood event.	During a flood event, considerable quantities of flood-fighting materials (e.g., rock, sandbags, lumber, and sheet piles) are often needed with minimal advance notice. Waiting until an event occurs to locate, purchase, and transport materials can slow the response to a flood emergency. During an event, the ability of local agencies to obtain funding is limited because contingency funding is small or nonexistent and banks are reluctant to lend.	Flood-fight materials and tools strategically located to improve flood-fight response times and reduce emergency costs and damages associated with a lack of timely access to these resources.	Flood-fighting materials could be purchased in advance of flood events and stockpiled at materials storage and transfer facilities. These material storage and transfer facilities could be located both locally (for immediate access) and regionally (near barge loading facilities or protected transportation corridors) and stocked based on assumptions related to the magnitude of flood event for which a response is desired, miles of levees supported, or other criteria. Stockpiles could be managed by both State and local agencies to provide access to bulk materials (rock, lumber, sheetpile) and portable materials (sandbags, plastic). Development of mutual-aid agreements for coordination and sharing of flood-fighting materials could be facilitated to leverage available funding and supply resources.	High initial costs. Majority of costs are upfront capital expenditures. Slight increase in annual costs related to storage and upkeep of flood-fighting materials.	None	High capital cost might reduce political and institutional support.	X	X	X	X	X	X	X	X			X													
FP-13	Integrate environmental compliance and mitigation into the flood fight.	Flood-fighting activities can sometimes lead to environmental violations (under CEQA and/or NEPA) that require extensive mitigation or result in an agency's disqualification for emergency funding reimbursements following an event. Many flood fights occur on or near flood facilities, which means sensitive wetland habitat, riparian areas, or coasts might be damaged by construction, heavy equipment, use of rock piles, or other activities that occur during flood fighting.	To complete flood-fighting activities, when necessary, while minimizing the potential for violating environmental regulations.	Hire or contract environmental compliance specialists who understand the nature of flood fighting and who can help prepare and train crews to minimize impacts to sensitive areas when addressing threats to levee stability. As soon as a flood risk is identified, these staff members would be involved in the field to help coordinate the flood fight; as flood threat is assessed, they would assess potential environmental impacts on existing conditions that could occur during flood fighting. Coordination with resource agencies, FEMA, and flood fighters would be needed.	Increase in initial costs and annual costs. There are additional costs to hire or train an environmental compliance or resource manager. However, these costs should be somewhat offset by no longer needing to hire outside consultants after a flood event to assist with more extensive mitigation.	Would minimize potential adverse environmental impacts. Would improve efficiency of the permitting process, and would decrease mitigation due to environmental violations.	This action would be harder to implement in smaller communities with fewer resources, but would be popular with resource agencies.	X	X	X	X	X	X	X	X			X	X			X					X			X	

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FP-14	Participate in the StormReady and TsunamiReady Program	Several communities have not achieved a basic level of flood or tsunami hazard preparedness. Several communities have no standard to evaluate their level of preparedness and do not know what steps need to be taken to improve their preparedness.	Communities that have achieved a certified level of flood/tsunami preparedness.	StormReady and TsunamiReady are nationwide community preparedness programs under the National Weather Service. The programs encourage communities, universities, counties, and other organizations to take a proactive approach to improve local hazardous weather operations by providing clear-cut guidelines on how to improve their hazardous weather operations, including establishing an emergency operations center, warning systems, public education, and emergency response plan. Guidelines for participation in the programs are based on population. A verification visit ensures that applicants meet program guidelines, and approval is granted from a local StormReady or TsunamiReady advisory board.	Although there are initial and annual costs for creating the disaster preparedness programs, systems, and processes needed to be certified under StormReady or TsunamiReady programs, costs of participation in the programs themselves are minimal.	None.	Participating in the StormReady or TsunamiReady program could help with a community's Community Rating System rating.	X	X	X	X	X	X	X	X			X													

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Policy and Regulations																															
PR-1	Use Building Code amendments to reduce consequence of flooding.	Mandatory building provisions related to flood protection that are required for the Special Flood Hazard Area (100-year floodplain) are provided by local Flood Management Ordinances. These ordinances address flood protection mainly through elevation of structures.	Additional mandatory Building Code provisions to protect residents from death or severe injury during floods, and increase the resilience of buildings to reduce damage and required time for recovery.	Jurisdictions could update their building codes to increase flood resilience. Adapt building code as appropriate to California hazards and vulnerabilities. Building code amendments could include various structural improvements for public safety reasons and for dry- and wet-proofing tactics to reduce overall consequences of flooding. Due to the various types of buildings and business sectors associated with each building occupancy category, the requirements might have to be customized for individual occupancy, in coordination with relevant State regulatory agencies and major industrial and professional groups. As with most building code amendments, the proposed code amendment could apply to new construction and existing buildings that require significant improvement and upgrade.	Relative low initial costs for implementing building code changes. The additional cost to implement the new codes, such as the added costs of building officials reviewing plans and permitting applications, could be recovered through additional fee requirements or development agreements. The additional cost to developers for meeting the new code requirements would be recovered through additional fees added to the lease or purchase price of the property. There might be an increase in annual costs associated with increased enforcement, inspection, and potential flood drills, subject to the actual code proposal.	If changes to policy or regulations would result in project implementation (e.g., physical impacts), CEQA compliance would be required.	Significant agency and interest group coordination would be required because of the various occupancy groups that might be affected by the proposed code amendment, and customization would be required. The application of building code amendments would be limited to new constructions and existing buildings with significant improvement and upgrade; therefore, it would not provide a uniform improvement on building safety and resilience during floods.	X	X	X	X	X	X	X	X		X															

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PR-2	Encourage multi-jurisdictional and regional partnerships on flood planning and improve agency coordination on flood management activities, including O&M, repair, and restoration.	Flood management is often complicated by the large number of agencies and entities involved, and their complex jurisdictional roles and responsibilities. Overlapping jurisdictions across various Federal and State agencies involved in flood management could lead to inconsistent policies and regulations, conflicting guidance, or inefficiencies in planning and implementing projects. Coordinating activities within this fragmented jurisdictional landscape could be challenging, particularly for local entities with limited resources.	The benefits of improved coordination could include streamlined permitting and approval processes; more efficient and cost-effective routine maintenance and repairs; more successful and sustainable environmental mitigation through regional coordination with conservation efforts; better leveraging of available funding sources; and flood management projects that provide multiple, mutual benefits.	Coordination between agencies and responsible parties could take many forms, including roundtable discussions, oversight committees, interagency liaisons, repurposed agencies, Joint Powers Authorities, Councils of Governments, or new entities. Improving coordination and cooperation might involve establishment of a new institutional framework, such as a systemwide, continuous, integrated group of responsible entities/agencies to oversee and coordinate flood protection and O&M of the flood management system. Another method would be to establish a single entity or resource with oversight responsibilities to streamline and provide guidelines for all planning, construction, maintenance, repair and restoration activities associated with flood management. With respect to emergency planning and response, a multi-agency coordination system could be developed to improve regional coordination, incident prioritization, and resource management in a major flood.	Low initial costs compared with structural measures. Potential to decrease annual O&M costs through streamlining and improving regional coordination.	No direct effects; however, improved coordination could foster integration of mitigation, restoration, and conservation activities across multiple agencies and jurisdictions, resulting in more successful rehabilitation of ecosystem functions.	Might be difficult to sustain coordination over the long term; individual agencies might be unwilling or unable to participate due to cost or governance structure.	X	X	X	X	X	X	X	X			X	X	X		X		X	X	X	X	X		X	X

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PR-3	Develop and implement criteria and processes for achieving a higher level of flood protection.	Currently, State law enacted in 2007 (Senate Bill 5) calls for urban and urbanizing areas in the Sacramento-San Joaquin Valley to achieve a minimum of 200-year (0.5% annual chance) flood protection by 2025. Other areas in California generally target 100-year level of protection because FEMA establishes protection from a 100-year flood event (1% annual chance) as the minimum level of flood protection for participation in the National Flood Insurance Program. The State encourages cities and counties to achieve higher levels of flood protection for their communities, if feasible. To implement these higher levels of protection, a robust set of criteria for evaluating existing and new flood infrastructure is needed to reflect new advances in geotechnical evaluation and exploration.	Robust and well accepted design and procedural criteria for cities and counties to make land use decisions and implement flood improvements.	Develop evaluation, design criteria and procedures to achieve higher levels of protection. Criteria would need to be consistent with established professional standards. The draft Urban Levee Design Criteria developed by DWR is one example of how this management action could be implemented for levees and floodwall improvements.	Development would require low initial costs. However, this would increase the cost of implementing future flood improvement projects.	Implementation results in additional modifications to the system, which might have positive and/or adverse environmental impacts and might require additional permits.	Would require broad agreement from many stakeholders (cities, counties, public officials, technical experts) to implement.	X	X	X	X	X	X	X	X			X													
PR-4	Clarify flood management responsibilities for local, regional, State, and Federal agencies.	There often lacks a consistent understanding of flood management responsibilities across local, regional, State, and Federal agencies regarding O&M, repair, improvements, inspection, and other activities. Although roles and responsibilities are specified through a combination of existing laws and regulations, agreements and disagreements frequently exist among Federal, State, and local agencies. Confusion occurs for various reasons such as dated regulations, incomplete records, precedence established through historical practices, lack of funding, lack of consistent enforcement, and conflicting management policies.	Improved understanding of flood management roles and responsibilities across local, regional, State and Federal agencies.	To clarify limits of responsibility, State, Federal and local agencies could identify responsibilities requiring clarification, refer to existing guidance, regulations, and agreements, and develop a common understanding of these issues.	Low initial costs. Measures put in place would consist of policies, plans, improved tools, and would not involve physical construction. This action would not impact the annual cost of O&M, but could impact the allocation of cost and responsibility.	None.	This management action would have a high level of support from maintaining agencies.	X	X	X	X	X	X	X	X			X													X

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Finance and Revenue																															
FR-1	Maximize funding for flood management projects by leveraging Federal funding.	Current Federal, State, and local funding mechanisms are not adequate to sustain effective flood management.	Maximize available funding for flood management projects.	Projects could be planned and developed specifically to leverage funding from multiple Federal sources, including FEMA, NFIP, Natural Resource Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), and USACE. This might include development of multiple benefit projects that leverage funding for a variety of Federal project purposes (flood risk reduction, environmental restoration, hazard mitigation, water supply, water quality), or development of projects that incorporate both structural and nonstructural actions addressing flood risk reduction and mitigation once flooding occurs.	Substantial local funding might be needed to meet cost-share requirements. Meeting Federal standards might require changes to project design. Annual O&M costs would not change.	None	Potential for broad public support; might require changes to laws or regulations at a Federal level (cost-sharing and/or appropriations); might require new local, State, or Federal programs.	X	X	X	X	X	X	X	X			X	X	X		X				X	X		X	
FR-2	Leverage funding from multiple projects to improve cost-effectiveness and efficiency of flood management projects.	There are often numerous projects occurring simultaneously in the same region, all of which conduct planning, design, permitting, and mitigation activities independent of each other. This could result in duplicate efforts and the potential for missed opportunities to provide mutual benefits.	Improve the cost effectiveness and financial feasibility of individual flood management projects by consolidating projects on a regional or systemwide level. Consolidating and coordinating planning and design activities could highlight opportunities to provide mutual benefits or multiple benefits beyond those planned as part of individual projects, could improve the effectiveness and sustainability of mitigation activities, and could leverage funding and implementation support from multiple sources.	Align new multiple benefit projects with other existing or planned projects (such as roads or highways) to leverage funding from multiple agencies and jurisdictions, increase construction and maintenance efficiency, combine mitigation efforts, and accomplish multiple objectives.	Low initial cost to implement. Annual O&M costs could be less with integrated projects, as opposed to multiple single-purpose projects pursued in isolation.	Key physical processes and ecosystem functions could be rehabilitated by combining funding requests of ecosystem restoration projects with flood management projects, increasing the likelihood for funding of both.	Potential for broad public support; would require increased coordination at State, Federal, and regional levels. Institutional, legal, and funding challenges exist.	X	X	X	X	X	X	X	X			X	X	X		X	X	X	X	X	X	X	X	X

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FR-3	Develop funding mechanisms for O&M and new flood management improvements.	Current State and local funding mechanisms are not sufficient in many cases to adequately sustain effective flood management. Investment in flood management has declined in recent years at all levels of government. Public funds available through various State grant, loan, and bond programs have helped bridge funding gaps for many local improvement projects. However, funding for these State programs is limited by budget constraints and political subjectivity. Federal cost-sharing for flood management projects has dropped in recent years.	Develop sustainable funding for flood system O&M and new construction for flood management.	There are many opportunities for funding flood management actions and improvements other than traditional taxes, bond funding, and grants. Alternate sources of funding should be considered for implementation of flood projects, including non-governmental organizations (NGOs), local or regional funding groups, or recreation fees. For example, there may be opportunities to collect fees from areas that share in the regional or statewide benefits provided by a robust flood management system but that do not directly receive flood protection.	Low initial cost to implement. Annual O&M costs would not change.	None	Jurisdictional and institutional roles and responsibilities would need to be established, depending on the mechanism; might require changes to existing laws or regulations governing funding and revenue generation for O&M and other flood management activities.	X	X	X	X	X	X	X	X			X													
FR-4	Establish a methodology for evaluating benefits and costs on a systemwide basis to support economic justification for projects in all community settings.	Existing criteria for determining cost-benefit analysis of projects is rigid. Some benefits that do not have an obvious monetary value might be excluded. In addition, if only the benefits to the immediate project area are determined, and not the benefits to the system as a whole, a project might underestimate benefits.	Cost-benefit analysis would show benefits to both the immediate area and systemwide. The value of benefits that do not have an obvious monetary value would be developed.	Develop a new set of criteria that is more inclusive and looks at all benefits for both the immediate area and the system as a whole. Methods to determine value of benefits that do not have an obvious monetary value should be developed.	Moderate initial costs. Criteria need to be developed and training needs to take place before cost-benefit analysis could begin. No direct impact on annual costs.	No direct impacts	This action would have a lot of support from communities with traditionally undervalued benefits of their projects.	X	X	X	X	X	X	X	X			X													
FR-5	Create shared strategic pooled money accounts, which would pre-fund avoidance and mitigation solutions for O&M impacts on current and future flood facilities.	Lack of funding can curtail effective environmental mitigation for routine O&M. One view holds that the current process for obtaining permits and mitigating potential O&M impacts cold exceed the budgets and resources of some maintaining agencies. Others contend that traditional O&M funding mechanisms were established during a time when maintenance activities were less sensitive to environmental impacts and did not consider the costs associated with O&M today.	Improved efficiency and cost-effectiveness of flood system O&M and associated mitigation.	When cost estimating is completed for a repair project or ongoing O&M activity, sufficient funds would be set aside for environmental mitigation. Funding for mitigation and O&M activities could be combined if planned in the early stages of a project. Creating a shared bank or other financial mechanism that pre-funds both O&M and mitigation would help improve the efficiency and cost effectiveness of both activities, and would make sure that lack of funding would not hamper achievement of mitigation goals.	Low initial costs to implement. Could reduce annual O&M costs. Funding of larger pooled mitigation areas with a single permit is more cost effective than several permits for individual sites.	Improving funding mechanisms for mitigation would improve the cost effectiveness of mitigation	Jurisdictional and institutional roles and responsibilities would need to be established; appropriate management and oversight for the funding bank would need to be identified; might require changes to existing laws or regulations governing funding for O&M and other flood management activities.	X	X	X	X	X	X	X	X			X				X					X				

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FR-6	Create a strategic pooled-money account that provides funds for land stewardship activities at current and future flood-related mitigation areas over perpetuity.	Some mitigation areas are unable to pay for the maintenance of the habitat that has been created in response to mitigation requirements for flood management facilities. Future projects could need alternatives for funding sources for land stewardship on the mitigation areas proposed by regulatory agencies. Mitigation is not a one-time expense and needs proper planning and funding for ongoing maintenance of mitigation areas.	Improved efficiency and cost-effectiveness of flood system land stewardship activities and associated mitigation areas.	When cost estimating is completed for a land stewardship activity, sufficient funds would be set aside for ongoing maintenance of mitigation lands. Creating a bank or other financial mechanism that pre-funds land stewardship activities would help improve efficiency and cost effectiveness, and would make sure that lack of funding would not hamper achievement of land stewardship goals.	Low initial costs to implement. No direct effects on annual O&M costs.	None	Jurisdictional and institutional roles and responsibilities would need to be established; appropriate management and oversight for the funding bank would need to be identified; might require changes to existing laws or regulations governing funding for land stewardship and maintaining mitigation areas.	X	X	X	X	X	X	X	X							X				X			X				

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Appendix C: Local Planned IWM Projects in California

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Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Central Coast	Monterey	Big Sur Land Trust Carmel River Floodplain Restoration and Environmental Enhancement Project		The initial Project action, commonly referred to as the Odello East Component in the following Initial Study, consists of (1) grading the existing farmland and access road to create an elevated agricultural preserve on approximately 40 acres on the southern edge of the Odello East site outside of the 100-year floodplain elevation; and (2) grading to restore the site's ecological function as a floodplain by creating the hydrological characteristics necessary to support floodplain restoration activities on approximately 55 acres of existing farmland. A portion of the agricultural preserve would be graded to accommodate future fill material as part of subsequent Project components/action. The second Project action, referred to as the Causeway Component, consists of replacing a portion of the SR 1 roadway embankment with a 520-foot-long causeway section. The third Project action, referred to as the Levee Component, consists of (1) removing approximately 2,400 linear feet of nonstructural earthen levees on the south side of the Carmel River channel, and (2) grading at the eastern boundary of the Project site on property owned by the Monterey Peninsula Regional Park District to encourage flood flows to enter into the south floodplain area at Odello East.	Yes	Agriculture
Central Coast	Monterey	Coastal Wetland Erosion Control and Dune Restoration	$1,070,164	The proposed project will enhance and restore wetland and sand dune ecosystems in central Monterey Bay and control erosion in salt marshes directly behind the dunes around Moss Landing. These marshes are critical buffers to prevent salt water from entering surrounding farmland, especially the Salinas Valley, yet they are eroding at accelerating rates. Sand dunes help retain fresh water at the coast, recharge groundwater, retard saltwater intrusion, and minimize storm damage from the sea. Currently, much of the physical dune structure around Monterey Bay is fairly intact, but it is also highly degraded with invasive non-native plants, which continue to spread. Monterey Bay is the largest indentation widely open to the sea on the Pacific Coast of the U.S., with correspondingly large and ecologically important dune systems, and it is the core area of the Monterey Bay National Marine Sanctuary. The target area for this project, the central Monterey Bay, has the lowest and most degraded sand dunes in the region. They will be the first to fail as sea level rises from storms, El Nino cycles, and climate change. Should they fail, salt water will overflow into the Salinas Valley, compromising one of the nation's most productive agricultural centers.	Yes	Ecosystem
Central Coast	Monterey	Continued Enhancement of Groundwater/Surface Water Models			Yes	Water Supply
Central Coast	Monterey	Implementation of the Moro Cojo Slough Management and Enhancement Plan: Restoration of the Upper Slough	$1,450,636	This project will involve the restoration of 120 acres of the Moro Cojo Slough containing tidal and brackish water marsh (a state marine reserve) that receive fresh water inputs from agricultural lands above. This project will restore the hydrologic connectivity of the upper, middle, and lower reaches of the Moro Cojo Slough by linking multiple marsh areas with new lands previously lost to agriculture. The project will reestablish an interconnected brackish water wetland ecosystem. The result of this project will be to reestablish hydrologic connectivity and ecosystem function, enhance wildlife habitat, reestablish wetland habitat that supports endangered species (brackish water snail and tidewater goby), and improve water quality flowing out of the watershed into several State marine reserves and the Monterey Bay National Marine Sanctuary. This will be a four-year project with three major outcomes: 1) protection of wetland marsh and adjacent upland habitats through easement or acquisition, 2) filtration of agricultural runoff with sediment basins and treatment wetlands prior to water entering the main slough 3) restoration of the main slough to increase open water habitat and overall system complexity, and 4) regain wetland habitat continuity between the three main sections of the Moro Cojo Slough.	Yes	Ecosystem
Central Coast	Monterey	Lower Carmel River and Lagoon Floodplain Restoration and Enhancement Project	$18,310,032	This program consists of 3 projects: Carmel River Lagoon and Beach Studies, Lower Carmel River Floodplain Restoration and Enhancement, and Hacienda Carmel Flood Bypass. The Carmel River Floodplain Restoration and Environmental Enhancement Project proposes to restore and enhance the hydrologic function and connectivity of the Odello East property with the lower Carmel River region and southern floodplain. The Project would 1) restore approximately 90 acres of historic coastal wetlands, upland habitat, and/or riparian habitat on existing agricultural land to enhance the site's capacity to function as part of the historical Carmel River floodplain and to provide additional habitat to the lower Carmel River ecosystem; 2) create an approximately 40 acre agricultural preserve to achieve the goal of preserving the agricultural heritage of the Project area in a manner that is compatible with adjacent habitat; 3) replace a segment of State Route 1 with a 520-foot causeway to improve floodwater conveyance under the highway and reduce flood hazards to SR 1 and 4) remove 2,400 feet of the south bank levee and "Blister" to allow the lateral dispersal of floodwater onto the south overbank area and Project site.	Yes	Ecosystem
Central Coast	Monterey	Northern Gabilan Mountain Watershed Management Project	$1,450,636	The project consists of three phases to restore a sub-watershed within the upper Gabilan watershed, and serve as a model for restoration of watersheds within the central coast. Phase I provides the foundational watershed characterization and process analysis necessary to develop meaningful and effective watershed management. It includes a review of previous relevant studies and preparation of original analysis along with a compilation of spatial data and key watershed processes. Analysis will be integrated with research and planning projects done by others. The synthesis of this information will be used to target planning and restoration for one sub-watershed. This will be accomplished by addressing the changes in the watershed functions and processes (physical, chemical and biological) that are caused by agriculture and urban activity that affect watershed health. Additionally, we will conduct a community-based engagement process to review Phase I information and watershed management options. Phase I will result in a management methodology and a master restoration plan for one of three sub-watersheds. Phase II will develop site design for prioritized restoration locations within the chosen sub-watershed and Phase III will implement those designs.	Yes	Ecosystem
Central Coast	Monterey	Pajaro River Parkway Plan		The Pajaro River Parkway Plan is a technical evaluation to identify public access and recreational opportunities that can be incorporated into the Levee Reconstruction Project. The plan will include an evaluation of expanding recreational opportunities within the Pajaro River levee reconstruction project area, engaging with the public, outreach and negotiation with landowners, development of alternatives, cost estimates, benefit analysis, environmental constraints analysis, and implementation plan.	Yes	Recreation
Central Coast	Monterey	Salinas Valley Water Project	$2,390,000	The Salinas Valley Water Project has three components – (1) enlarging the spillway at Nacimiento Dam to handle a maximum probable flood, (2) prolonging releases of water to the Salinas River so that the basin's groundwater can be recharged; and (3) installing a diversion structure on the Salinas River near Marina to temporarily store and divert water during dry periods. That water, about 10,000 acre-feet per year, will be pumped to the Castroville Seawater Intrusion Project area, thus further reducing groundwater pumping and recharging the area's aquifers to hold off seawater intrusion. During winter months, the diversion structure will be lowered so that water can flow to Monterey Bay and endangered steelhead trout can migrate up river to spawn in Arroyo Seco River and other upstream waters. Flow rates will be maintained in the river and fish screens installed to support steelhead migration.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Central Coast	Monterey	Water Quality Enhancement of Tembladero Slough Phase II	$609,525	This project is Phase II of Water quality enhancement of the Tembladero Slough and Coastal Access for the Community of Castroville, Phase I of which has been funded by the IRWM Plan Round 1. During Phase I, CCWG will work with County agencies, agricultural land owners and the community of Castroville for design and permitting of a select set of water quality/wetland management structures. These projects will utilize a variety of water quality management innovations, including the treatment train approach (i.e., detention/sedimentation features, pollutant filtration/ biological degradation of pollutants and water polishing areas). During Phase II of this project, 20 acres in total (approximately six projects) will be constructed based on the plans from Phase I that support and integrate the multiple objectives of the GMC IRWM Plan, emphasizing urban and agricultural water quality enhancement, flood management, habitat restoration and support of various watershed planning and permit processes. Features are selected based on available space, hydrologic requirements, and adjacent landowner concerns, but preferentially support projects that enhance habitat and open space features, as well as improve water quality.	Yes	Water Quality
Central Coast	Monterey	Watershed Approach to Water Quality Solutions	$475,562	This project will improve water quality in multiple impaired bodies of water within the Lower Salinas River Watershed that are listed on the 303d list for pollutants such as nutrients, pesticides, sediment, and bacteria. These bodies of water include the Salinas Reclamation Canal, Santa Rita Creek, and Tembladero Slough; considered the most polluted bodies of water on the Central Coast with 37 TMDL listings. In agricultural areas, efforts will focus outreach and referrals for existing programs that will leverage funding for implementation of irrigation and nutrient management practices and Livestock and Lands program, while implementing much needed management measures such as erosion control for strawberry crops. Restoration projects along Santa Rita Creek will be installed to promote environmental stewardship, reduce illegal dumping, expand the floodplain, stabilize banks and increase biofiltration of pollutants through revegetation of native plants. Of utmost importance is the development of tracking tools for management measures and water quality monitoring to build a knowledge base. This project has been funded through Round 1 IRWM Implementation Grant funds.	Yes	Water Quality
Central Coast	San Luis Obispo	Flood Control Zone 1/1A Waterway Management Program		The program will increase the capacity of the lower 3 miles of Arroyo Grande Creek with levees while simultaneously enhancing water quality and sensitive species habitat within the managed channel.	Yes	Water Quality
Central Coast	San Luis Obispo	Morro Bay Harborwalk		The City of Morro Bay, in cooperation with the Morro Bay National Estuary Program and the County of San Luis Obispo, will be constructing multimodal transportation system improvements that include enhancement and rehabilitation of approximately 5 acres of coastal dune habitat. Of these, 1.75 acres will be treated with aggressive non-native species abatement followed by native revegetation using locally collected native seed; the remaining 2.99 acres will receive non-native species abatement with native species recruitment for restoration. Stormwater filtration and management measures will also be included in the construction.	Yes	Ecosystem
Central Coast	San Luis Obispo	San Luis Obispo Waterway Management Plan	$36,620,000	Program will provide flood protection while simultaneously enhancing water quality and sensitive-species habitat in the San Luis Creek watershed from the City of San Luis Obispo to Avila Beach	Yes	Water Quality
Central Coast	Santa Barbara	Las Vegas/San Pedro Creek		The Santa Barbara County Flood Control District (CFCD) in partnership with Caltrans is proposing hydraulic capacity improvements along Las Vegas and San Pedro Creeks under Calle Real, Route 101, and the Union Pacific Railroad (UPRR). The proposed project would increase the hydraulic capacity of the two creeks from a 10-year to a 25-year stormwater event	Yes	Transportation
Central Coast	Santa Barbara	Lower Arroyo Burro Restoration Program		Design and implementation of creek bank stabilization and riparian habitat restoration projects on a reach-by-reach basis within the lower Arroyo Burro watershed. A collaborative project of the City, County and private landowners, restoration projects would include large scale modifications to the creek channel (widening, creation of floodplains, natural grade control structures, etc.), removal of key invasive plant species, installation of native plant species, and improvements to public access. The restoration efforts would be designed and implemented in order to reduce erosion, reduce flood risks, improve water quality, improve wildlife habitat and diversity, and improve educational and recreational opportunities.	Yes	Ecosystem
Central Coast	Santa Barbara	Upper Mission Creek Flood Management and Habitat Improvement Project		Removal of half of the concrete bottom slab for the entire mile of the channel, excavation of several feet into the underlying materials and construction of a natural-bottom creek channel with areas of lowered concrete embedded roughness. Results will include restoration of over 1 mile of creek channel and the creation of over 1 acre of wetland habitat, including removal of three fish passage barriers as well as removal and replacement of non-native plants with native plants.	Yes	Ecosystem
Central Coast	Santa Clara	Lower Llagas Creek Flood Protection Project and Creek Capacity Restoration Project	$8,300,000	Restoration project to address reduced channel capacity in system with levees. May remove existing levees to widen floodplain. Project goals include: 1)Evaluate the current flood risk in the area surrounding the project versus the design level flood risk; 2) Develop options to provide flood protection for Lower Llagas Creek Reach 2 beyond the Soap Lake Floodplain in accordance with FEMA criteria; 3) Identify opportunities for environmental restoration and corridor preservation. The project will restore flood capacity in Lower Llagas Creek; coordinate with South County Wastewater Authority as a principal stakeholder and water resource co-planner; and integrate flood protection with habitat protection to satisfy Endangered Species Act regulations.	Yes	Ecosystem
Central Coast	Santa Clara	San Juan Basin Surface Drainage		San Benito County Water District (SBCWD) has proposed surface water detention and drainage alternatives in the San Juan Basin area that can be integrated with an existing Caltrans reconstruction plan for Highway 156 between San Juan Bautista and Hollister. This plan will provide surface water detention and water quality benefits to a tributary of the Pajaro River, thereby assisting with stormwater runoff quality concerns and also reducing peak flows from the San Juan Basin into the Pajaro River.	Yes	Water Quality
Central Coast	Santa Clara	Soap Lake Floodplain Preservation Project (High Priority Project)	$18,405,050	The Soap Lake Project, Phase 1 provides nonstructural flood protection through preservation of approximately 9,000 acres of agricultural lands. It is the first phase of the long-term recommended non-structural, 100-year flood protection project developed by the Pajaro River Watershed Flood Prevention Authority (FPA). The Project provides flood protection in the lower Pajaro River Watershed by preserving the Soap Lake floodplain. The floodplain provides natural flood storage and attenuation characteristics for the Pajaro River watershed and reduces the flow that needs to be conveyed through the downstream channel.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Central Coast	Santa Cruz	38th Avenue Detention Basin Retrofit	$500,000	The proposed project is a retrofit of a County maintained detention basin to accommodate low flows. The detention basin is at the intersection of 38th Avenue and Brommer Street. It is an open-bottom basin that was designed to provide flood storage volume during large storms that exceeded the flow capacity of the downstream system. The basin is offline and water enters the basin only during high-flow events. All low flows currently bypass the basin through a pipe system. This project concept includes reconfiguring the inlet and outlet so that low flows can enter the basin and have the opportunity to be filtered through a vegetated path and infiltrated into the open channel. This project should help to reduce the volume and increase the quality of the urban runoff discharging to the channel downstream of the project site.	Yes	Water Quality
Central Coast	Santa Cruz	Gully G Drainage Improvement	$1,771,000	Project includes structural BMPs to reduce flow rate, promote infiltration, and decrease sediment load in the Gully G drainage.	Yes	Water Quality
Central Coast	Santa Cruz	LID Demonstration Projects	$750,000	The proposed project is the implementation of low-impact development (LID) measures that can be retrofitted into the existing County government facilities at 701 Ocean Street in Santa Cruz, California. Measures that will be considered for this project include: porous pavement, biofilters (e.g., swales, biorentention, buffer strips, landscape planter box), rainwater reuse, soil amendments, disconnected downspouts, drought tolerant planting in place of turf, green roofs, tree planting, solar panel installation and others. These facilities should serve to benefit stormwater quantity and quality leaving the site and entering the San Lorenzo River. This project will also provide highly visible demonstrations of how LID components can be incorporated into existing site design.	Yes	Water Quality
Central Coast	Santa Cruz	Lower Pajaro Valley and Watsonville Sloughs Conservation Planning and Funding Incentives Program	$60,000	The purpose of this project is to identify and prioritize strategic land conservation opportunities in the lower Pajaro Valley and Watsonville Sloughs to achieve multiple resource benefits; develop specific funding and implementation strategies; and engage key landowners to help them understand the financial benefits associated with easements and other conservation funding. We hope to catalyze a pilot conservation project that adds to the network of protected lands, and demonstrates how easement funding can offset or incentivize land fallowing or other water conservation actions that reduce agricultural income.	Yes	Ecosystem
Central Coast	Santa Cruz	Pajaro River Watershed Study	$1,000,000	The purpose of the Pajaro River Watershed Study would be to complement the ongoing development of the Pajaro River Flood Control Project by investigating management measures that are important to improving the overall public acceptability of the flood damage reduction project, but are outside of the scope of the project authorization. The Pajaro River Flood Control Project was authorized in 1966 as a single-purpose flood-damage-reduction project. As a single-purpose project, only flood-damage-reduction benefits can be used to justify Federal investment in the project; however, stakeholders have identified other outputs, such as geomorphic stability and steelhead habitat improvements, that are important for overall public acceptability of the project. The watershed study provides a means to investigate these other outputs. The watershed study would also provide information that will complement the ongoing Soap Lake Preservation Project and other proposed water resources projects in the Pajaro River Watershed.	Yes	Ecosystem
Central Coast	Santa Cruz	Soquel Creek Linear Park, Parking Improvements, Habitat Restoration, Flood Mitigation and Urban Greening Project	$1,500,000	Park project is located in Santa Cruz County, California, within Soquel Village. The Agency's parcels (030-153-10 and 24) and others represent over 2 acres in Soquel Village along Soquel Creek. The project will implement the Soquel Village Plan; the proposed Soquel Creek linear park design will involve neighboring parcels and will provide economic vitality, improved vehicular and pedestrian circulation, parking and business waste infrastructure consolidation, water quality and quantity with stormwater BMPs and low-impact design, accessible recreational uses, including nature pathways, open and civic spaces, riparian habitat restoration partnerships among the community, private and public entities, including the Agency, the Soquel Village Parking and Business Association, County Parks, Santa Cruz County Resource Conservation District, Soquel History Association, and others.	Yes	Water Quality
Central Coast	Santa Cruz	Stormwater Allocation Program (SWAP) for Santa Cruz County	$600,000	To meet State-mandated stormwater hydromodification requirements, new development and redevelopment is required to offset any increases in stormwater runoff. Normally, this is achieved using on-site controls. However, a significant number of projects do not have the space/capacity onsite to meet this requirement. The ability to utilize offsite facilities to meet the hydromodification requirement would benefit water quality, groundwater recharge, and development/redevelopment. The project will evaluate the potential for trading of stormwater capacity (volume) credits within the City of Watsonville. Trading would allow for hydromodification required projects within watershed boundaries instead of specific site boundaries to allow for a greater benefit to water quality, quantity, and overall watershed	Yes	Water Quality
Central Coast	Santa Cruz	Update of the Arana Gulch Watershed Assessment and Enhancement Plan (2002) Phase I and generated Phase II	$160,000	Update the 2002 Arana Gulch Watershed Assessment and Enhancement Plan and to generate a Phase II Plan. Phase I Plan has been the guiding document for implementing identified restoration projects within Arana Gulch. Accomplishments to date include 10 of the highest priority Phase I restoration projects improving water quality and wildlife habitat throughout the watershed. Phase I plan calls for a review every 10 to 12 years to re-evaluate the Plan against current conditions, guidelines, and regulations (completed in 2000, thus revision is more than a year late). Phase II will address current conditions within the watershed and identify areas for reducing peak flows that are central to diminishing sediment-related issues. Additional opportunities for resource management will be evaluated such as revisitation of Phase I projects yet to be implemented, increased Arana Gulch watershed advocacy, flow gauge installation, annual stream-walk monitoring.	Yes	Water Quality
Central Coast	Santa Cruz	West Watsonville Slough Project	$14,500,000	Purpose of protecting and enhancing freshwater coastal wetlands, improving floodplain function in Watsonville Slough, preserving agricultural lands and providing compatible public access.	Yes	Ecosystem
Colorado River	Riverside	San Jacinto River Gap Project	$40,000,000	The project consists of a soft-bottom channel with levees from Sanderson Avenue to a point about 10,000 feet west and then northwest about 6,000 feet to Bridge Street. The channel will have capacity for about a 25-year storm event (31,000 cfs). There will be grade control structures in the channel. Enhanced habitat values will be provided along the channel alignment so it can be used as a corridor to connect the San Jacinto Wildlife Area (SJWA) between the Portrero and Davis Units of the SJWA. This project would prevent flows up to the 25-year storm from breaking out across agricultural land and thereby reduce nutrient loading to storm runoff; it would make an important contribution toward the delisting of Canyon Lake and Lake Elsinore as impaired water bodies; it would provide critical habitat corridor linkage for the Portrero and Davis Units of the SJWA (the SJWA is the No. 1 priority habitat area in Riverside County for the Multispecies Habitat Conservation Plan); it would provide managed habitat for the Los Angeles Pocket Mouse and San Bernardino Kangaroo Rat; and it would respect water rights in the region.	Yes	Ecosystem
Colorado River	Riverside	Cushenbury Flood Detention Basin	$2,000,000	The project is proposed to capture runoff from the San Bernardino Mountains in the Lucerne Valley Sub-basin. Currently, large storm flows drain to dry lakebeds in the area that have low percolation rates. Consequently, the majority of water that drains to the lakebeds is lost to evaporation and never enters the basin. The project would divert storm flows to detention basins with high rates of percolation to decrease losses from evaporation.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
North Coast	Del Norte	Klamath River Estuary Wetland Restoration Prioritization		The document develops guidance for prioritizing wetland restoration projects required through compensatory mitigation.	Yes	Ecosystem
North Coast	Del Norte	Requa Bridge Deck Raise			Yes	Transportation
North Coast	Humboldt	Mattole Integrated Watershed Management Initiative	$4,459,000	The Mattole Integrated Watershed Management Initiative provides a comprehensive approach to watershed restoration in the Mattole through stream-flow enhancement, riparian restoration, coho salmon recovery rearing, stream flow and turbidity monitoring, sediment stabilization, and removal of invasive plants. Seven water storage tanks will be installed in the Mattole headwaters totaling 350,000 gallons to augment summer stream flows in critical reaches of coho salmon habitat. Residents agree to turn off in-stream pumps when directed and begin using water from storage tanks. Recovery rearing of coho salmon will be implemented as a temporary measure to avoid extirpation until stream flow and habitat issues are more fully addressed in the headwaters. Downstream work to control sediment will take place through the installation of bioengineered willow fences, as well as reduce active erosion and increase streamside shade through the planting of native riparian trees, shrubs, and grasses. Invasive plants will be removed on project sites prior to implementation, and turbidity and stream flow monitoring will ensure that project goals are met.	Yes	Ecosystem
North Coast	Humboldt	Rohner Creek Flood Control and Salmonid Habitat Improvement Project	$5,000,000	The Rohner Creek Flood Control and Salmonid Habitat Improvement Project is a watershed-based, channel corridor-scale project with multiple objectives. The project is intended to provide immediate and substantial improvements to channel corridor function that will benefit aquatic organisms and reduce flood frequency within the City of Fortuna. Rohner Creek, at its confluence with Strongs Creek (located approximately 1,000 feet upstream from the Eel River), has a 4.5-square-mile watershed ranging in elevation from 25 to 1,600 feet. The upper portion of the watershed predominately consists of second- and third-growth redwood forest, whereas the mid-portion consists of rural residential areas. The lower portion of the watershed is comprised of residential, commercial, and industrial land uses and within the City limits of Fortuna. Through historic channelization and encroachments, Rohner Creek through the urbanized reach of Fortuna experiences overbank flows on a 1.5-year recurrence. Historic attempts to reduce flooding throughout the corridor have resulted in the absence of complex and diverse in-stream habitats suitable to support native stocks of salmonids including Chinook salmon, steelhead trout, and the State and Federally listed Coho salmon. The proposed project is taking a channel corridor approach in identifying opportunities to integrate habitat enhancement elements with flood-reduction improvements through the 1-mile project corridor within the City of Fortuna. Conceptual design-level hydrologic, hydraulic and geomorphic analyses are currently evaluating a suite of improvement opportunities throughout the project corridor. These improvements will address localized streambank mass wasting, channelization, and the absence of salmonid habitat elements throughout the corridor. These improvements will benefit ecological and hydraulic function of the corridor focusing on in-stream features and riparian plantings that will improve corridor habitats while reducing flood frequency. Once the improvements are identified and associated opinion of probable costs are developed, the City will prioritize the projects and commence final design, CEQA documentation, and permitting to support the priority projects as available funding allows.	Yes	Ecosystem
North Coast	Humboldt	Salt River Restoration Project by Humboldt County Resource Conservation District, and California State Coastal Conservancy	$5,950,000	Project will improve channel conditions in the Salt River by removing sediment from the channel. Nuisance in-stream vegetation will be removed and replaced with an appropriate composition of managed riparian vegetation. Setback levees will be used on the tributaries to promote natural sediment deposition trends on the alluvial fan. Sediment detention basins will be used to reduce suspended sediment levels. Erosion sources in the upper watershed will also be treated.	Yes	Water Quality
North Coast	Mendocino	Big River Main Haul Road Phase I Restoration	$2,063,630	The Big River Main Haul Road Phase I Restoration project proposes to remove ecological obstructions (crossing fills, culverts, and stored sediment) at five locations that threaten water quality in the lower Big River watershed; restore sections of Class II tributary channels; construct bridges high above the restored channels to maintain access for ongoing restoration, compatible recreational use, and scientific study; remove invasive weeds that threaten wetland, riparian, and forest habitats in both the Big River and watershed. Four roadway watercourse crossings and one fill-slope failure along the main access road of the park are composed of significant volumes of fill, are actively eroding, and have trapped substantial volumes of sediment (approximately 14,000 cubic yards). Culverts conveying water through the fill prisms were constructed high above the natural stream channel and are too small to convey the 100-year floodwaters. The fill prisms and stored sediments exist in Class II watercourses and represent an ecological obstruction between forested uplands and the Big River estuary and floodplain, which occur 100 to 300 feet downstream of the crossings. Non-native plants have invaded sensitive habitats, impacting listed species such as coho salmon and steelhead trout.	Yes	Water Quality
North Coast	Sonoma	Copeland Creek Enhancement and Restoration Project	$13,314,257	• California Natural Resources Agency 2011 Environmental Enhancement and Mitigation Program Grant: $345,480. • Local Funds $ 4,220,647 • DWR IRWMP Prop 84 Round 1 Grant Program: $1,000,000. (Sub-agreement of grant award to County of Humboldt – North Coast IRWMP).	Yes	Ecosystem
North Coast	Sonoma	Defining Summer Low Flow Channels in Engineered Streams	$450,000	The overall goal of this project is to reduce sediment delivery and facilitate sediment movement in engineered stream reaches to be determined by this project. Possible candidates that have active watershed-based approaches and are familiar to IRWMP are Corte Madera Creek, Lagunitas Creek, Guadalupe River and Alameda Creek. Sediment management will be accomplished by improving and / or removing flood control structures, and stabilizing stream banks and creating / restoring thalwegs. These multiple efforts will improve summer habitat for the nationally threatened steelhead.	Yes	Water Quality
North Coast	Sonoma	Laguna de Santa Rosa Sedimentation Study and Projects	$20,000,000	The Conservancy will assist the Sonoma County Water Agency (SCWA) with the proposed Phase II of the Laguna sedimentation study. Phase II will involve the assessment for and preparation of detailed designs for one or more projects on publicly owned land that will reduce effects of sedimentation for habitat restoration and flood control. Phase II will additionally include preparation of the environmental documentation for the chosen project(s). Phase II follows the nearly completed Phase I of this study, which was initiated because SCWA requested USACE to determine if siltation has impacted the ability of the Laguna to provide wildlife habitat and to act as a flood control basin. Phase I, therefore, evaluates the causes of sedimentation and assesses restoration needs.	Yes	Water Quality

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
North Coast	Sonoma	Multiple benefit Flood and Runoff Management for Sonoma Valley	$10,000,000	This project addresses long-standing flooding, water supply, and water quality needs in the Sonoma Creek watershed, including the City of Sonoma, a Phase II stormwater municipality. The proposed activities continue many years of work toward achieving water management goals in the watershed. Aimed at reducing long-term environmental effects of ditching, draining, and paving, the project will reduce volume and velocity of storm runoff delivered to streams; enhance riparian corridors and increase canopy coverage; implement run-off BMPs on residential, vineyard, and horse properties, both in the upper watershed and along streams; reduce suspended sediment loads; and increase information sharing with our citizen and agency community.	Yes	Water Supply
North Coast	Sonoma	Multiple benefit Stormwater Management and Groundwater Recharge for Petaluma River Watershed	$10,000,000	Provide 100-year flood protection and increase groundwater recharge potential.	Yes	Water Supply
North Coast	Sonoma	Multiple benefit Stormwater Management and Groundwater Recharge for the Santa Rosa Plain	$10,000,000	Core Objectives: • Flood Hazard Reduction – Improve management of stormwater that contributes, directly or indirectly to downstream flooding, thereby reducing flood hazards. • Groundwater Recharge – Increase beneficial recharge of groundwater, whether or not that recharged groundwater is directly accessible as water supply	Yes	Water Supply
North Coast	Sonoma	Russian River Groundwater Banking (Artificial Storage and Recovery) Study		Groundwater Banking Feasibility Study initiated in 2010 for banking excess winter water from the Russian River in the Sonoma Valley groundwater basin for storage and use in the summer or during drought period. Conceptually, a groundwater banking program would divert and transmit surplus Russian River water produced at the Agency's existing production facilities and store that water in the Santa Rosa Plain Groundwater Basin and/or Sonoma Valley Groundwater Basin during wet weather conditions (i.e., the winter and spring seasons), for later recovery and use during dry weather conditions (i.e., the summer and fall seasons) or emergency situations.	Yes	Water supply
North Coast	Sonoma	Santa Rosa Creek Ecosystem Restoration Study	$20,000,000	Ecosystem and flood management and detention basins	Yes	Ecosystem
North Coast	Trinity	Trinity River Restoration Program		Program activities include physical habitat modifications to the river, monitoring of river responses, and reviews and recommendations for future modifications or enhancements to current management actions (e.g., flow releases from dams, fishery harvests, hatchery practices).	Yes	Ecosystem
North Lahontan	Alpine	Markleeville Creek Restoration Project	$220,700	The goal of the Markleeville Creek Floodplain Restoration Project is to reestablish the natural form and function of Markleeville Creek through the site of the former U.S. Forest Service Guard Station. The Alpine Watershed Group proposes to restore the streambed configuration to more closely resemble its natural state which will improve geomorphic function and restore the floodplain.	Yes	Ecosystem
North Lahontan	Lassen	Develop On-stream and Off-stream water storage to store floodwater and to store water for use during drought conditions			Yes	Water Supply
North Lahontan	Lassen	Susan River Parkway Project, inclusive of $0.5 million of flood management components	$3,500,000	This project is for bank stabilization and flood control, provide recreation, increase habitat, create river parkways and for conservation efforts.	Yes	Recreation
North Lahontan	Nevada	Trout Creek Restoration Project (Reaches 4 and 5) - Truckee	$10,500,000	The grant funds requested would construct and restore two reaches Reach 4 and 5 of Trout Creek. Restoration of the two reaches would traverse lands owned by Holiday Development and would require infrastructure improvements to create the optimal stream restoration alignment. Infrastructure improvements include moving the balloon track adjusting the Glenshire Drive alignment and constructing two new bridges across Trout Creek to support the relocated balloon track.	Yes	Ecosystem
North Lahontan	Nevada	Trout Creek (Truckee) Flood Control and Restoration	$2,743,000	Project includes bank stabilization, stream environment zone restoration, enhanced fish habitat, newly created riparian habitat, public outreach and education improved water quality of Truckee River, and flood protection for Truckee River corridor.	Yes	Ecosystem
South Lahontan	Inyo	Inyo/Mono Watersheds Invasive Weed Control Program	$461,257	This project aims to control and eradicate invasive weeds that impact recreation, air quality, fire hazards, water issues including increased erosion leading to increased sedimentation, lowered quality, and decreased flood control capacity, and native habitat issues	Yes	Water Quality
South Lahontan	Inyo	Oak Creek Watershed Fire/Flood Restoration Phase I	$355,760	This is a three-phase project design. Phase One is the study and engineering portion of the project, which has begun with a Bureau of Reclamation grant to asses watershed and Oak Creek irrigation system issues. The tribe is requesting IRWMP funding to be used for the vast engineering of up to three flood diversions, two reservoirs, 3 miles of creek restoration, and up to 500 acres of irrigation system as a portion of Phase One.	Yes	Water Supply
South Lahontan	Los Angeles	45th Street East Flood Control Basin	$22,500,000	Construction of drainage basin (2,083 acre-feet) near 45th Street East and Avenue P-8 on Los Angeles City Department of Airports property. This project will integrate with the construction of the Avenue Q and 20th Street East detention basin for flood control, and it will provide possible groundwater recharge and natural habitat preservation.	Yes	Water Supply
South Lahontan	Los Angeles	Amargosa Creek Pathways Project (Lancaster)	$1,300,000	The Amargosa Creek Pathways Project, proposed by the City of Lancaster, includes development of a top of bank trail or paseo along eastern side of Lake Lancaster, and construction of a foot-bridge structure crossing the lake and connecting under Highway 14 to link to the existing trailhead at the Antelope Valley Region Fairgrounds. The project integrates stormwater/flood control with natural riparian habitat enhancement and preservation, open/recreational space and land use management. The goal is to construct a pathway in harmony with established riparian habitat, within a flood control management basin which captures stormwater and nuisance water runoff that, in turn, sustains riparian habitat. This project will additionally increase the amount of protected natural habitat and provide improved flood control within the Amargosa Creek watershed.	Yes	Recreation

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Lahontan	Los Angeles	Amargosa Creek Recharge and Channelization Project	$13,500,000	This project will increase the Antelope Valley's water supply, increase the amount of protected natural habitat and provide improved flood prevention within the Amargosa Creek watershed. Proposed improvements include expanding the size and capacity of the spreading ground of the natural recharge area; developing and preserving an ephemeral stream habitat; and channelizing Amargosa Creek (soft bottom); and providing a grade separation of 20th Street West over the Amargosa Creek. This project will integrate with the construction of the 20th Street West bridge over Amargosa Creek, the channelization of Amargosa Creek between 25th Street West and 20th Street West, and the natural habitat preservation, and with existing upstream and downstream Amargosa Creek improvements.	Yes	Water Supply
South Lahontan	Los Angeles	Anaverde Detention Basin, Dam & Spillway at Pelona Vista Park	$10,000,000	Construct Pelona Vista Dam-grading, inlet/outlet structures, spillway, and storm drain piping. This project is a multipurpose flood control basin that has the ability to provide for wildlife habitat, conservation, and stormwater capture.	Yes	Ecosystem
South Lahontan	Los Angeles	Avenue Q and 20th Street East Basin (Q-west basin)	$12,500,000	Acquisition and construction of a 1,612-acre-foot detention basin between Avenue P-12 and Avenue Q, from 20th Street East and 30 Street East or on LAWA's property from Avenue P-8 to Avenue P-12. This project will integrate with the construction of the 45th Street East and Avenue P-8 detention basin for flood control, and it will provide possible groundwater recharge and natural habitat preservation.	Yes	Water Supply
South Lahontan	Los Angeles	Barrel Springs Detention Basin and Wetlands (Palmdale)	$10,000,000	Construction of an 878-acre-foot detention in the Barrel Springs area upstream of Old Harold Road and 25th Street East on a 40-acre, City-owned property. This project will provide flood control for the City of Palmdale, wetland enhancement, and habitat protection.	Yes	Ecosystem
South Lahontan	Los Angeles	Hunt Canyon Groundwater Recharge and Flood Control Basin (Palmdale)	$10,000,000	Construction of detention/recharge basin, south of Pearblossom Highway, at 57th Street East. Basin is to have a 3,000-acre-foot capacity. The basin will also be used for storing aqueduct raw water to recharge into the aquifer and to control floodwaters. The proposed project would alleviate flooding and have the potential to provide a recharge area for raw aqueduct water.	Yes	Water Supply
South Lahontan	Inyo	West Walker River Channel Rationalization	$225,000	This is an opportunity to merge holistic flood control planning along with riverine enhancement. Currently, the river on the site is flat and unbounded, washing away farm soil and offering little chance for recovery of what, before the 1997 flood, had been a rich fishery environment. By incorporating natural "breakout" levees, flood events could be cost-effectively controlled, while influencing the river course in directions where historic tree-canopy fishing "hole" refuges could be restored. Pilot area for planning is a 3-mile section of the river.	Yes	Ecosystem
South Lahontan	Mono	West Walker River Restoration Plan	$80,000	The goal of this project is to develop a restoration plan via the completion of an assessment of the riverine and riparian conditions associated with approximately 3 miles of the West Walker River located within the Antelope Valley, which is designated as an economically disadvantaged community. The Antelope Valley in Northern Mono County is home to roughly 15,000 acres of actively farmed land contributing significantly to local livelihoods. The West Walker River is also ecologically important to imperiled, native trout. However, this same area has experienced significant damage from stormwater events that have in turn resulted in significant impacts, including loss of productive farmlands, from flooding of the Walker River. Most recently, in 1997, a 100-year flood event occurred resulting in extensive losses of productive farmland and deleterious impacts to the Walker River ecosystem. Today, threats from stormwater and flood events remain, and losses of active riparian farmlands occur annually. Better understanding of the historical and current geomorphological processes associated with the West Walker River along with assessing the current riparian habitat condition is the first step in developing a comprehensive stormwater/flood management that will provide the basis for long-term management of this economically and ecologically important portion of the Inyo-Mono IRWM region. This project will pay particular attention to assessing approximately three miles of the lower West Walker River system with the intent of developing management recommendation to ameliorate the threat to stream bank stabilization and in doing so, contribute positively to local livelihoods and local fisheries.	Yes	Ecosystem
South Lahontan	Los Angeles	Upper Amargosa Creek Flood Control, Recharge, and Habitat Restoration Project	$6,983,322	This project will consist of a suite of activities designed to improve flood control, reduce dependence on imported water by stabilizing current groundwater levels (a source of local supply), and protect the environmental habitat.	Yes	Water Supply
South Lahontan	Mono	Mountain Gate Trail and Restoration Project		The site was previously frequently damaged by flooding. The project would establish recreation and habitat at the site.	Yes	Recreation
South Lahontan	Mono	Rush Creek Floodway Improvements		Increase the capacity of the Rush Creek floodway at Silver Lake to minimize flooding and maximize peak flow events up to 750 cfs that benefit the riparian ecosystem.	Yes	Ecosystem
South Lahontan	San Bernardino	Amethyst Detention Basin	$12,100,000	The County proposes to construct Amethyst Basin (formerly known as Oro Grande Basin No.9), with combined detention and stormwater recharge capabilities. The basin will include the construction of associated inlet and outlet structures, channels and/or closed conduits, transition structures, wingwalls, headwalls, cutoff walls, basin embankments, emergency spillways, and access roadways along tops of the embankments and around the basins and access ramps to the basin floor.	Yes	Water Supply
South Lahontan	San Bernardino	Antelope Valley Wash Recharge Ponds	$800,000	Antelope Valley Wash Recharge Ponds could provide groundwater recharge upgradient from City of Hesperia wells. The Hesperia Master Plan of Drainage identifies a 65-acre site for a stormwater detention basin in the Antelope Valley Wash south of Ranchero Road. In addition to stormwater detention, the site might be able to accommodate groundwater recharge. The Morongo Basin Pipeline passes by this area and would be the source of recharge water.	Yes	Water Supply
South Lahontan	San Bernardino	Cedar Street Detention Basin	$2,000,000	Cedar Street Detention Basin may provide the opportunity for recharge upgradient from the City of Hesperia wells. The Hesperia Master Plan of Drainage identifies a potential site for a stormwater detention basin at the east end of Cedar Street and southwesterly of the California Aqueduct. In addition to stormwater detention, the 120-acre site might be able to accommodate groundwater recharge. The California Aqueduct would be the source of recharge water.	Yes	Water Supply
South Lahontan	San Bernardino	Desert Knolls Wash, Phase 3	$9,000,000	Construct the Desert Knolls Wash Reaches II and III flood protection, water quality and water conservation project. The project emphasizes the national goals of EPA to plan the development and use of land through preservation and enhancement of rivers, tributaries and streams, as well as the land drained thereby.	Yes	Water Quality
South Lahontan	San Bernardino	Mojave River I-15 Levee	$1,360,000	Construct the Mojave Levee Phase II flood protection project in the amount of $700,000. The project emphasizes the national goals of the EPA to plan the development and use of land through preservation and enhancement of rivers, tributaries, streams, as well as the land drained thereby.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Lahontan	San Bernardino	Mountain View Acres	$7,065,000	Construct the Mountain View Acres flood protection, water quality and water conservation project in the amount of $4 million. The project emphasizes the national goals of EPA to plan the development and use of land through preservation and enhancement of rivers, tributaries, streams, as well as the land drained thereby.	Yes	Water Quality
South Lahontan	San Bernardino	Ranchero Detention Basin	$12,075,672	Construct the Ranchero Basin flood protection, water quality and water conservation project to help meet water demands and foster sustainable development in the rapidly developing communities, incorporating the latest science, engineering technology, climate models and dual-purpose basin innovation.	Yes	Water Supply
Tulare Lake	Fresno	Eastside Water Quality and Urban Reliability Project	$20,000,000	The project includes both a direct groundwater recharge elements (Traver Groundwater Bank) and a surface water treatment plant that will provide a reliable supply of high-quality water to the current and future residents in the Cutler and Orosi Communities and surrounding unincorporated communities. All of the areas to be served are disadvantaged communities. The direct recharge elements of the project will also capture and recharge stormwater and integrate flood retention benefits; enhance environmental wildlife habitat; and provide flexibility in operation, water control, and utilization.	Yes	Water Supply
Tulare Lake	Fresno	Fancher Creek Flood Control Improvement Project - City of Fresno	$4,462,173	The Fancher Creek Detention Basin removes 682 acres from the 100-year floodplain, redirects runoff that may contain pollutants into stormwater management basins, and result in approximately 740 acre feet of additional surface water recharge per year. Once complete, the basin will have sufficient capacity to provide the 100-year control of the Fancher Creek flows.	Yes	Water Quality
Tulare Lake	Fresno	Fresno Irrigation District Joint Conjunctive Use Project	$10,000,000	The Fresno Irrigation District (FID) Joint Conjunctive Use Project is a cooperative effort of the Fresno Irrigation District, a second undisclosed district, and other local and State agencies. This project intends to utilize resources that are available to the District that may not currently be maximized and to supplement the FID water supplies. The project is an agricultural project that may ultimately provide water to urban and agricultural suppliers and facilitate the environmental benefits of improving the Kings River fishery. The project consists of expanding the recharge and banking facilities along the Kings River in Fresno and Kings Counties in the vicinity of the Peoples Weir for diversion of unregulated Kings River flood flows, Central Valley Project (CVP) contract water, 215 CVP floodwaters, and potentially other sources. Recovery wells will be installed to allow for a portion of the stored groundwater to be extracted. The project is a conjunctive use project, as the available water supply will be diverted to the expanded facilities for recharge and storage in the groundwater reservoir.	Yes	Water Supply
Tulare Lake	Fresno	Kings River North Fork Flood Projection and Wildlife Enhancement Project	$3,274,512	The Kings River North Fork Flood Protection and Wildlife Enhancement Project is located on the Kings River in northern Kings County, an area historically prone to flooding prior to the development of the Kings River Channel Improvement Project by the U.S. Army Corps of Engineers and the Kings River Conservation District. The flood project was authorized by the U.S. Congress in 1944 and completed in 1972. Due to its character and age, the project does not comply with current design or levee constructions standards. The project utilized setback levees at many locations, incorporating existing conforming agricultural uses into the project. The agricultural uses provide benefit to the flood project in most locations; however, there is a flow constraint resulting from a large agricultural island at one location in the system. This location is immediately downstream from Island Weir and is upstream from State Highway 41.	Yes	Ecosystem
Tulare Lake	Fresno	McMullin On-Farm Flood Capture and Recharge Project	$5,500,000	This project is Phase 1 in a multiple-phase project to capture Kings River flood flows and utilize those flows for on-farm conjunctive use activities (i.e., direct recharge, in lieu recharge, irrigation). These objectives will be achieved through a combination of flood easements on 250 acres; upgrade to structures (e.g., turnout along the Kings River, McMullin Grade Crossing, Terranova Canal); and implementation of Flood Flow Capture (FFC) Best Management Practices (BMPs) on 1,250 acres. On-farm FFC activities are economically motivated by chronic and severe groundwater overdraft in the Kings Basin threatening the viability of farming. Phase 1 will divert flood flows through a 500-cfs-capacity turnout onto farm fields for conjunctive use activities developed under a current NRCS pilot study. Phase 1 targets capturing (when available) 150 cfs of winter flood flows for direct recharge (9,375 acre-feet per month); 1,800 acre-feet for replenishing root zone moisture, and an average of 2,025 acre-feet per month for in lieu recharge. Under Phase 1, the legal entity McMullin Flood Flow Capture District, composed of supporting landowners and others involved in groundwater and flood flow, issues will be formed. These technical, organizational, and logistical efforts will be the foundation of subsequent phases increase the conjunctive use acreage to 5,000 acres to divert 500 cfs onto farms for recharge. At completion, this project will have the capacity to recharge 30,000 acre-feet per month for direct recharge in the winter, 4,800 acre-feet to replenish soil moisture, and an average 5,400 ac-ft/month for in lieu recharge during the spring. The Kings River is managed by KRWA in coordination with USACE and its management of the San Joaquin River. This project will have the capacity to divert up to 10% of Kings River flood flows (entering into the Mendota Pool through the James Bypass) and greatly ease flood-flow pressures at that location, as well as at areas upstream along the Kings River and downstream in the San Joaquin River.	Yes	Water Supply
Tulare Lake	Kern	Caliente Creek Habitat Restoration - Feasibility Study	$500,000	The project consists of a study to determine the feasibility of acquiring land upstream of Highway 58 and restoring habitat in order to intercept floodwater and help mitigate routine flooding of Arvin and Lamont.	Yes	Ecosystem
Tulare Lake	Kern	Calloway Cross Valley Canal Intertie	$13,700,000	Modify conveyance systems to enhance exchanges and delivery of supplies to in-lieu and direct absorptive capacity.	Yes	Water Supply
Tulare Lake	Kern	Cuddy Creek Restoration Project – Phase 1	$1,000,000	Stabilization and restoration of approximately 3000 feet of Cuddy Creek to reduce watershed soil erosion and sedimentation of surface water to reduce the discharge of pollutants to State waters from storm or nonpoint sources.	Yes	Water Quality
Tulare Lake	Kern	Kern County's Southern San Joaquin Valley Flood Mitigation Plan	$10,000,000	This plan consists of 40 coordinated projects that can be constructed to enhance groundwater recharge, preservation of habitat, and manage flood and debris flows from the various watersheds that drain into the Southern San Joaquin Valley portion of Kern County.	Yes	Water Supply
Tulare Lake	Kern	Kern River Shoreline 48 Acres	$550,000	With the help of numerous volunteer groups, irrigation water mains and lateral lines will be installed as part of the restoration projects. The project will extend water lines and restore an additional 48 acres of Kern River shoreline and floodplain. The water will maintain native trees which will be planted along the highly visible Kern River floodplain. The project will include the replanting of riparian vegetation, approximately 500 trees/shrubs and installation of California native "golden" grass seed mix to enhance the natural Kern River habitat area. This project will implement a more environmentally sensitive flood management regime by relieving the tendencies for erosion of levees and riverbanks, thereby reducing the need to build levees higher or performing expensive rehabilitation of damaged levees. The addition of trees and native vegetation at the project site will resolve flood damage issues for floods up to the Standard Project Floods that exceed a 100-year storm.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Tulare Lake	Kern	Pipeline Connecting Friant-Kern Canal in Support of Flood Storage Reservoir in Poso Creek Drainage	$75,000,000	The proposed project is to connect the Friant-Kern Canal to a proposed 50,000-acre-foot flood storage reservoir in the Poso Creek drainage area east of State Highway 65. Stored floodwater would be delivered for irrigation.	Yes	Water Supply
Tulare Lake	Kern	Rock Meadow Riparian Vegetation Restoration (32 acres)	$32,000	Fence off and restore approximately 32 acres of riparian vegetation along the Kern river. Replant native trees and bushes. Install an irrigation system.	Yes	Ecosystem
Tulare Lake	Kern	Storm Water Filtration and Retention Project	$500,000	Installation of stormwater recapture and filtration units within the city limits and surrounding areas. Water will be placed in retention basins for use on irrigation projects.	Yes	Water Supply
Tulare Lake	Kings	Kings River Critical Levee Repairs	$5,000,000	Restoration and protection for the Kings River Conservation Districts Kings River levees.	Yes	Recreation
Tulare Lake	Kings	North Fork Recharge Sites 11 and 16	$750,000	Groundwater management construction project.	Yes	Water Supply
Tulare Lake	Kings	River Ranch Valley Oak Habitat Restoration & Groundwater Recharge Project, South Fork Kings River	$7,000,000	Environmental and habitat protection and improvement conservation project.	Yes	Ecosystem
Tulare Lake	Tulare	Paregien Basin Project	$2,150,000	This Project consists of a 78-acre groundwater recharge basin, associated structures and monitoring wells that would capture floodwaters for groundwater recharge. The basin is in an established riparian state which is to be preserved and enhanced.	Yes	Water Supply
Tulare Lake	Tulare/Kings	Upper San Joaquin River Basin Storage Investigation	$62,251,000	DWR, U.S. Bureau of Reclamation, and their partners have developed a two-phase Plan of Study. Phase 1 will identify water resource opportunities and issues in the Upper San Joaquin River watershed. This phase will include an appraisal of opportunities to increase surface storage and conjunctive uses for groundwater. Phase 2 will be more detailed and will begin with public meetings to determine the scope of the study. Various dams on the Kings and San Joaquin Rivers and their tributaries. Or off-stream reservoirs within the Tulare Lake or San Joaquin Hydrologic Regions. The purpose of the Upper San Joaquin River Basin Storage Investigation is to determine the type and extent of Federal, State, and regional interests in a potential project in the upper San Joaquin River watershed to improve water supply reliability and flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts.	Yes	Water Supply
Sacramento River	Butte	Murphy Slough Habitat Restoration		Modifications to existing flood relief structures and bank protection works.	Yes	Ecosystem
Sacramento River	Colusa	Colusa Sub Reach Wildlife Habitat Restoration Project		This project proposes the restoration of approximately 251 acres of wildlife habitat on portions of seven tracts within the levees of the Sacramento River between the community of Princeton and the City of Colusa.	Yes	Ecosystem
Sacramento River	Colusa	Cooperative Program for Groundwater Studies between the County of Glenn and the Colusa Basin Drainage District		This program includes investigating the potential for groundwater recharge in conjunction with the operation of flood detention facilities prior to design and construction as part of the Colusa Basin's Integrated Watershed Management Plan.	Yes	Water Supply
Sacramento River	Colusa	Integrated Resources Management for Flood Control		This project consists of three alternatives. Alternative 1: Construction of 14 detention basins and 10,000 acres of environmental restoration measure. Alternative 2: Construction of 8 detention basins and 10,000 acres of environmental restoration measure. Alternative 3: Construction of 5 detention basins and 10,000 acres of environmental restoration measure.	Yes	Ecosystem
Sacramento River	Colusa	Long-term flood management for Colusa Basin		A combination of strategically placed foothill reservoirs and up to 10,000 acres of multipurpose detention basins, catchment basins, and groundwater recharge facilities along the Colusa Drain and/or tributaries provide the most reasonable technical, environmental, and economical structural solution to significantly remedy the issues of flood control and groundwater recharge within the Colusa Basin.	Yes	Water Supply
Sacramento River	Colusa	Sites Reservoir		Provide water supplies in average and dry years for urban, agricultural, and environmental purposes. Sites Reservoir will add flexibility to the State's water management system and can provide unique benefits, which include: (1) enhanced water supply reliability for urban, agricultural, and environmental uses; (2) improved Delta water quality; (3) mitigation of snowpack storage losses due to climate change; (4) contribution to flood damage reduction in the Central Valley; (5) ecosystem restoration actions in the Sacramento River; (6) dedicated storage that can be adaptively managed to respond to Delta emergencies and help with restoration actions.	Yes	Water Supply/ Ecosystem
Sacramento River	Colusa	Upper Stony Creek Watershed Project		In addition to managing watershed resources, provide groundwater recharge and flood control by diverting and transporting peak flows through a series of man-made waterways or pipelines joining Walker and Wilson Creeks with the existing gravel sites.	Yes	Water Supply
Sacramento River	El Dorado	Finnon Lake Restoration and Habitat Improvement Project - Georgetown Divide Resource Conservation District	$1,501,400	Restoring Finnon Lake back to its original operating capacity of 350 acre-feet while enhancing fishery and aquatic habitats, improving wetland habitat, improving upland forest habitats, and securing a sustainable water supply to combat wildfires.	Yes	Ecosystem/ Water Supply
Sacramento River	El Dorado	Hangtown Creek Restoration (South Fork American River Watershed)	$24,046,050	Objectives include: (1) develop a comprehensive flood control plan for the City of Placerville; (2) complete the Hangtown Creek Master Plan; (3) relocate the trunk sewer lines out of the creek channel; (4) upgrade three sewer lift stations within the Hangtown Creek watershed; and (4) ongoing restoration of Hangtown Creek and its tributaries.	Yes	Water Quality
Sacramento River	El Dorado	Regional Water System Reliability and Conservation Project for American and Yuba river watersheds	$18,000,000	Improve reliability of raw water conveyance and storage, and improve water conservation by eliminating seepage and minimizing evaporation, improve and protect raw water quality for downstream municipal and domestic water users; protect fisheries from a damming source of sediment and increase the capacity of raw water conveyance and storage to meet anticipated future demands.	Yes	Water Quality/ Water Supply
Sacramento River	Glenn	Colusa Subreach Wildlife Habitat Restoration Project		Develops a strategy for restoration of the ecosystem along the Sacramento River between the community of Princeton and the City of Colusa.	Yes	Ecosystem
Sacramento River	Glenn	Design of Recharge/Detention Basins		Continue investigation and design of recharge/detention basins on South Fork Willows Creek and Wilson Creek.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Sacramento River	Glenn	Hamilton City Flood Damage Reduction and Ecosystem Restoration		Construction of a setback levee to provide a more reliable form of flood protection to the community and agricultural areas. Degradation of the existing "J" levee to allow for reconnection of the river to the floodplain, and restoration of approximately1,500 acres of native habitat between the new setback levee and the Sacramento River.	Yes	Ecosystem
Sacramento River	Glenn	Integrated Resources Management for Flood Control		This project has three alternatives. These alternatives include: construction of 14 detention basins and 10,000 acres of environmental restoration measure; construction of 8 detention basins and 10,000 acres of environmental restoration measure; construction of 5 detention basins and 10,000 acres of environmental restoration measure.	Yes	Ecosystem
Sacramento River	Glenn	Willows Area		Project is in development; alternatives include a nonstructural approach, a structural approach, and a combined approach. Goal is to reduce flood damages to the City of Willows and surrounding agricultural lands while increasing ecological value within the South Fork Willow Creek, North Fork Willow Creek, and Wilson Creek Sub-basins in Glenn County	Yes	Ecosystem
Sacramento River	Lake	Cache Creek Flow Enhancement Project		Determine mercury and nutrient inputs to Clear Lake to support the development and implementation of water quality protection measures	Yes	Water Quality
Sacramento River	Lake	Middle Creek Project - Wetland Restoration		Eliminates flood risk to 18 residential structures, numerous outbuildings and 1,650 acres of agricultural land while restoring damaged habitat and the water quality of the Clear Lake watershed.	Yes	Ecosystem/ Water Quality
Sacramento River	Lassen	Ash Creek Wildlife Area Restoration Project	$3,700,000	The project is a meadow restoration project (2,415 acres) on the lower section of the Ash Creek Wildlife Area. It will also protect 1,085 acres from further degradation. It will provide flood attenuation and shallow groundwater recharge.	Yes	Water Supply
Sacramento River	Lassen	Beaver Creek Meadow Restoration Project	$800,000	The project is a meadow restoration project that will restore approximately 100 acres of a degraded meadow system and will also provide flood attenuation and shallow groundwater recharge.	Yes	Water Supply
Sacramento River	Lassen	Butte Creek Meadow Restoration Project	$350,000	The project is a meadow restoration project that will restore approximately 150 acres and will provide flood attenuation and shallow groundwater recharge.	Yes	Water Supply
Sacramento River	Lassen	Floodplain Restoration at Egg Lake Slough-Lennon Ranch		The project will enhance and stabilize 0.5 miles of riverbank along Egg Lake Slough, improve habitat conditions, and keep the slough from further degradation and transport of high flows.	Yes	Ecosystem
Sacramento River	Lassen	Mountain Meadows Restoration Project	$4,700	Three separate project reaches proposed for meadow restoration to reestablish floodplain function, reduce fine sediment, improve forage production, and enhance habitats for wildlife and aquatic species.	Yes	Water Quality/ Ecosystem
Sacramento River	Modoc	Alturas Area Levee and Enhancement Project		The project would redesign the levee system and channel through the city in a manner that is up to USACE standards, protects the infrastructure of the city, minimizes risk of debris accumulation and improves the aesthetics of the waterway to increase commercial activity in that part of town.	Yes	Recreation
Sacramento River	Modoc	Diamond Ranch/Canyon Creek Meadow Rehydration Project	$110,000	The project will enhance a stream by placing grade control structures, which will be designed to stabilize banks and encourage flood flows to access the floodplain. The project will provide flood protection, groundwater recharge, and habitat enhancement.	Yes	Water Supply/ Ecosystem
Sacramento River	Modoc	Green Wing Properties River Bank and Wetlands Restoration Project		This project consists of riparian and wetland restoration along with watershed improvement in the surrounding upland areas. Beneficiaries of the project include landowners and general public.	Yes	Ecosystem
Sacramento River	Modoc	Haage Ranch Riverbank Stabilization Project and Riparian Enhancement Project	$300,000	The project will enhance and stabilize 1.5 miles of riverbank along the Pit River, improve habitat conditions, and keep the river from further degradation and transport of high flows	Yes	Ecosystem
Sacramento River	Modoc	Hunsinger Draw Meadow Restoration Project	$80,000	The project is a meadow restoration project (30 acres) along Hunsinger Creek that will provide flood attenuation, shallow groundwater recharge, and ecosystem restoration.	Yes	Water Supply/ Ecosystem
Sacramento River	Modoc	Parker Creek Restoration and Enhancement Project		This project proposes to conduct a variety of natural resource treatments including forest restoration, stream restoration, and habitat enhancement within the Parker Creek watershed.	Yes	Ecosystem
Sacramento River	Modoc	Proposed Willow Creek Ranch/LLL, Inc. Riparian and Wetland Enhancement Project		The project will consist of riparian and wetland enhancement along with watershed improvement in the surrounding upland areas.	Yes	Ecosystem
Sacramento River	Modoc	Rattlesnake Creek Riparian Enhancement	$350,000	The project will enhance 3 miles of stream by placing grade control structures, which will be designed to stabilize banks and encourage flood flows to access the floodplain. The project will provide flood protection, groundwater recharge, and habitat enhancement.	Yes	Water Supply/ Ecosystem
Sacramento River	Modoc	Sponseller Ranch Riverbank Stabilization Project and Riparian Enhancement Project	$210,000	The project will enhance and stabilize several miles of riverbank along the Pit River, improve habitat conditions, and keep the river from further degradation and transport of high flows	Yes	Ecosystem
Sacramento River	Placer	Dry Creek Watershed Flood Control and Environmental Enhancement Project - Dry Creek Parkway Reach	$5,727,395	Project will reduce flood damages and enhance environmental quality of the Dry Creek Watershed by: purchase of easement and fee interests or real properties within the flood corridor, improving channel and floodplain connectivity by renovation of existing dam and removal of private non-engineered levees, establishing salmonid spawning habitat, and removal of 100 acres of red sesbania in lower watershed.	Yes	Ecosystem
Sacramento River	Placer	Dry Creek Watershed Flood Control and Environmental Enhancement Project – Miner's Ravine	$2,800,835	Reduce flood damages and enhance environmental quality of the Dry Creek Watershed by: constructing an off-channel detention basin in Placer County. Riparian and in-stream habitat improvements would benefit steelhead and many other wildlife species. Enhancements include removal of non-native plants, creating riparian habitat, enlarging stream channel and allowing for meander and restoration of natural processes including enhancement of seasonal wetlands.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Sacramento River	Placer	Lakeview Farms Conservation Project	$495,527	This conservation project is being proposed as a collaborative effort with two partners: Lakeview Farms Inc. and Ducks Unlimited to acquire a conservation easement and improve the floodplain and wetland habitat resources on Lakeview Farms, a 138-acre property south and west of Sheridan along Coon Creek in western Placer County. The County's purchase of a conservation easement on this agricultural rice land is a part of a larger restoration effort at this site, through other funding sources, to restore the habitats that have been destroyed as a result of poor farm management. Wetlands habitat will be reconstructed to the primary benefit of the numerous waterfowl and migratory birds that are found in the area.	Yes	Ecosystem
Sacramento River	Placer	Proposed Antelope Creek Flood Control Project	$5,839,747	This is a multiple objective water efficiency and regional flood control improvement project proposed within the Dry Creek Watershed area of the American River Basin. The project will meet multiple planning objectives by improving water supply, water quality, flood protection, ecosystem restoration and an existing public recreation corridor. Through the design and construction of several on-channel weirs along an existing open space protected reach of the creek, the project will provide flood control and flood damage reduction benefits to repeatedly damaged areas of downtown Roseville. Both ecosystem restoration and public recreational opportunities will be enhanced wherever possible within the floodplain of Antelope Creek, which currently includes a multiple purpose public trail system. In-stream improvements will include bank re-contouring to ensure overbank flows, specific habitat enhancements for fisheries, removal of invasive plant species and replanting with natives. An interpretive trail sign system is also proposed to help educate the public on the project as they utilize the existing multiple purpose trail system.	Yes	Water Supply/ Water Quality/ Ecosystem/ Recreation
Sacramento River	Placer	Proposed Regional Cross Canal Watershed Flood and Conservation Easement Project		In exchange for monetary payment, a qualifying property owner can continue agricultural activities while allowing rice lands to be periodically inundated with water during large winter storm events. This would include rice lands adjacent to Auburn Ravine, Markham Ravine, Pleasant Grove Creek, Coon Creek, Yankee Slough and their tributaries. The goal of the easement program is to conserve these rice lands and the riparian corridors along existing creeks to the mutual benefit of the Flood Control District and the property owner. Under this program, rice growing operations in new easement areas would not be altered but rather protected and conserved. Existing wetland and riparian areas adjacent to creeks would be improved and protected, any current waterfowl hunting operations could remain and the property owner would receive fair market value for the sale of an easement.	Yes	Ecosystem
Sacramento River	Plumas	Fitch Canyon Restoration Project		Restore meadow to reestablish floodplain function and improve habitats for wildlife and aquatic species.	Yes	Ecosystem
Sacramento River	Plumas	Integrated Greenhorn Creek Restoration Project	$87,910	Treatment of six project reaches along Greenhorn Creek stabilizing eroding stream banks and the channel bed with boulder vanes, bank sloping and vegetation to reduce sediment and loss of property, and the construction of two fish passable riffle-pool structures to improve fish passage.	Yes	Ecosystem
Sacramento River	Plumas	Last Chance Creek Phase II Restoration Project	$2,867,750	Restore the hydrologic function of 542 acres of meadow to reestablish floodplain, stabilize 7.8 miles of channel along Last Chance Creek to eliminate gullied channel as sediment source, and enhance meadow habitat.	Yes	Ecosystem
Sacramento River	Plumas	Red Clover Confluence Restoration Project	$128,300	Restore the hydrologic function of approximately 2,100 acres of channel/floodplain system using pond and plug technique in Red Clover Valley. The primary project goal was to improve the water and sediment retention functions of the watershed, with objectives focusing on reduced bank erosion, improved water quality, improved fish and wildlife habitat, reduced flood flows, and increased base flows. Agencies participating or providing funding to this project include a consortium of 24 public and private sector groups.	Yes	Water Quality/ Ecosystem
Sacramento River	Plumas	Rowland-Meadowview Restoration Project	$98,500	Restore the hydrologic function of 256 acres of meadow along Rowland Creek and Last Chance Creek to reestablish floodplain, eliminate gullied channel as sediment source, and enhance meadow habitat.	Yes	Ecosystem
Sacramento River	Plumas	Spanish Creek in American Valley Rehabilitation project	$38,100	Treatment of three project reaches along Spanish Creek implementing gravel management through removal of gravel bars to expand floodplain capacity; stabilizing eroding stream banks with bank sloping, boulder vanes, and vegetation; and rehabilitating aquatic/riparian habitats.	Yes	Ecosystem
Sacramento River	Plumas	Spanish Creek in Meadow Valley Rehabilitation Project	$531,050	Treatment of four project reaches along Spanish Creek, stabilizing eroding stream banks with bank sloping, boulder vanes, and planting vegetation. Also entails the implementation of gravel management through removal of gravel bars to expand floodplain capacity, reduce bedload sediment and bank erosion, and rehabilitate aquatic/ riparian habitats.	Yes	Ecosystem
Sacramento River	Plumas	Sulphur-Barry Creek Restoration Project	$19,000	Reduce sediment and restore floodplain along Sulphur and Barry Creeks to reestablish hydrologic function, reduce bed load transport, and eliminate gullied channel as sediment source.	Yes	Ecosystem
Sacramento River	Plumas	Upper Dotta Canyon Restoration Project	$549,914	Restoration of 253 acres of meadow floodplain and 2.9 miles of stream channel to reestablish hydrologic function, eliminate gullied channel as sediment source, and enhance meadow habitat potentially utilizing the pond and plug technique.	Yes	Ecosystem
Sacramento River	Plumas	Yellow Creek - Humbug Valley Restoration Project	$388,400	Restoration of 109 acres of meadow floodplain to reestablish hydrologic function, eliminate gullied channel as sediment source, and enhance meadow habitat.	Yes	Ecosystem
Sacramento River	Sacramento	American River Basin IRWM Stormwater Flood Management Grant Proposal – Downtown Combined Sewer Upsizing Project	$6,899,208	The Downtown Combined Sewer Upsizing Project will reduce flood damage in the economically vital downtown area of Sacramento; improve water quality in the Sacramento River through the reduction in raw sewage releases into the source of drinking water for millions of Californians; and protect public health by reducing the likelihood and volume of diluted sewage on public streets and properties.	Yes	Water Quality
Sacramento River	Sacramento	Arcade Creek Corridor Plan	$1,000,000	This plan identifies numerous remedial and maintenance projects along Arcade Creek and Cripple Creek that will fulfill the goals of the Arcade Creek Watershed Group. The types of projects identified are as follows: remove debris jam and flow obstructions, remove invasive nonnative vegetation, stabilize banks, improve pipe outfalls, restore recreational trails, improve floodplain function, reconfigure the channel, control runoff from parking lots, stabilize swales, remove sediment and vegetation at creek crossings, remove concrete-lined channel. Identified projects are located within the City of Sacramento, Sacramento County, and the City of Citrus Heights.	Yes	Recreation

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Sacramento River	Sacramento	Dry Creek Flood Hazard Mitigation Acquisitions with County Park Dept.		The Dry Creek Parkway project is a multi-agency project designed to return an area of Dry Creek floodway to a regional park site and open space. The floodway at this location is very broad compromising access during flood emergencies. The Parkway project goals and good floodplain management mandate the removal of the remaining residential structures located within the floodway. At this time, 21 residential structures are still remaining.	Yes	Recreation
Sacramento River	Sacramento	Elder and Gerber Creek	$70,000,000	The North Vineyard Station Drainage Master Plan for Elder and Gerber Creek improvements has a Clean Water Act Section 404 Permit and will improve flood flow conveyance, store peak flow volume, and enhance habitat.	Yes	Ecosystem
Sacramento River	Sacramento	Gardenland Flood Management, Habitat Restoration, and Recreation Project	$5,140,324	The Gardenland Sand and Gravel mine site is a 123-acre site on a floodplain terrace located within the designated boundaries of the American River Parkway. Sacramento Area Flood Control Agency proposes to acquire the site, restore it, and incorporate it into the publicly-owned American River Parkway. The site has been mined for decades and is now used for sorting, distributing, and recycling soil and construction debris. The dominant feature is a steep-sided, 62-acre mine pit that is now a lake, hydraulically linked to the American River through alluvial soil. It hosts non-native fish and vegetation, and the graded soils around the pit are either bare or host non-native vegetation and weeds. The site operators mow and disc much of the property to prevent the establishment of vegetation, particularly woody vegetation that would inhibit mining operations. Acquisition of the site would remove two occupied dwellings and various structures and equipment from the floodway. It would provide an opportunity to restore the site and eliminate the ongoing potential for sedimentation and water pollution from the on-site storage of piles of soil and debris of unknown origin.	Yes	Water Quality
Sacramento River	Sacramento	South Sacramento Habitat Conservation Plan		The South Sacramento Habitat Conservation Plan (SSHCP or Plan) provides a regional approach to balancing development against conservation and protection of habitat, open space, and agricultural lands. The SSHCP protects 30 species of plants and wildlife including 10 that are listed as threatened or endangered under the Federal Endangered Species Act (ESA), the California Endangered Species Act (CESA), or both. The SSHCP also protects vernal pool, wetland, and stream habitats that are subject to the Federal Clean Water Act (CWA) and California's Porter-Cologne Water Quality Control Act. The SSHCP also seeks a programmatic Streambed Alteration Agreement under CDFW Code Sections 1600, et seq. The primary mechanism for conservation established under the Plan is the SSHCP Reserve System, which will conserve habitat that will be managed and monitored to achieve the biological goals and objectives for the covered species.	Yes	Ecosystem
Sacramento River	Sacramento	Stormwater Source Control in the Cosumnes American Bear and Yuba Region - American Rivers	$1,020,000	This project will construct green infrastructure stormwater facilities to reduce sediment, pollutants, and erosive peak flows, while increasing groundwater infiltration and storage in the Yuba River watershed. It will also provide a highly exportable, innovative solution for controlling downstream flood risk. The project will be constructed at two public sites in the disadvantaged communities of Nevada City and Grass Valley—the Nevada County Rood Administrative Center (Rood Center) and the Yuba River Charter School (YRCS). The proposed approaches mimic nature's way of dealing with stormwater and provide not only economic, water quality and hydrology benefits, but also aesthetic and habitat values. In addition, the project has an innovative and robust monitoring component to quantitatively measure benefits, incorporates education and outreach activities for a range of audiences, and coordinates with other such efforts throughout the state to promote early learning and replication throughout the Cosumnes, American, Bear and Yuba (CABY) watersheds and the greater Sierra Nevada region.	Yes	Water Quality
Sacramento River	Shasta	Burney Gardens Restoration Project	$1,600,000	The project is a meadow restoration project of an open meadow area (estimated budget of $75,000) and the restoration of an encroached lodgepole meadow area ($1.5 million estimated budget). Removal of biomass and sale of this product is anticipated to pay for the restoration of the encroached meadow area. The project also provides flood attenuation and shallow groundwater recharge benefits.	Yes	Water Supply
Sacramento River	Shasta	Clover Creek Preserve	$10,597,753	The Clover Creek Preserve project proposes to restore and conserve approximately 128 acres of land that had been slated for residential development. Specific components of the project include the creation of a 46+ acre detention basin/floodplain area (with 10 to 15 acres of associated seasonal wetland, marsh, perennial pond and riparian habitat); the enhancement or creation of 25 to 40 acres of oak woodland and 40 to 55 acres of grassland with scattered vernal pools; and the construction of bike paths, walking trails, a parking area, and habitat interpretive areas.	Yes	Ecosystem/ Recreation
Sacramento River	Shasta	McArthur Swamp Restoration and Management Planning Project	$600,000	The project would develop a restoration design plan that would use surface flow water to restore seasonal wetlands and vernal pools in the project area.	Yes	Ecosystem
Sacramento River	Sutter	Lower Feather River Watershed Management Plan (WMP)		The Feather River Watershed Forum was established to implement watershed management and restoration activities in the Feather River watershed of northern California.	Yes	Ecosystem
Sacramento River	Sutter	Stream Systems Hillslope Processes Mining		One of the goals is to evaluate stream banks/levees and floodplain connectivity.	Yes	Ecosystem
Sacramento River	Sutter	Sutter Basin Feasibility Study		The project assesses flood risk, ecosystem restoration, and recreation issues.	Yes	Ecosystem
Sacramento River	Tehama	Deer Creek Levee widening (upstream of SR 99)		Redesign and widen of the Deer Creek levee to meet current needs due to capacity issues. Modeling results of existing conditions suggest that portions of the existing levee system are overtopped as low as 10,000 cfs. Reconstructing and setting back the levee on both sides of the stream would increase the floodplain and increase the transitory storage capacity, restore channel form and function to improve O&M and facilitate flood damage reduction, remove barriers to fish passage, set back levees to connect rivers to floodplains, restore channel alignment, encourage natural physical geomorphic processes including channel migration and sediment transport, protect critical infrastructure corridors from floodwaters (MA-069). This project is an effort to respond to the flooding and habitat problems in lower Deer Creek and explore the concept of deliberately using the floodplain of Deer Creek to accommodate part of the flood flows in a controlled fashion. With careful planning and adequate protections for vulnerable property and infrastructure, this project will seek to reduce flood flows and allow the channel to reestablish some of its irregular, hydraulically rough, and ecologically complete pre-levee condition.	Yes	Ecosystem
Sacramento River	Tehama	La Barranca and Blackberry Island	$5,590,050	The proposed project is a comprehensive floodplain reconnection and restoration project (Phase III) within the Sacramento River National Wildlife Refuge. 450 acres on the La Barranca Unit and 50 acres on the Blackberry Island Unit will be restored, including: the removal of gravel pits, removal of a 900-foot private levee and roads to reconnect the river and its floodplain, control invasive weeds, and replanting with native riparian species. The reconnection will improve floodplain storage, reduce peak flood flows and protect property.	Yes	Ecosystem/ Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
Sacramento River	Yolo	Bridge District Levee Access Road	$4,500,000	Project would develop a levee maintenance and flood-fighting access road, spanning 3,250 linear feet (0.6 miles) on top of the levee crown, from the south side of the Tower Bridge to the future Mill Street, north of U.S. Highway 50. The proposed access road and off-road amenities would also serve as a recreational trail by allowing controlled use by bicyclists, pedestrians, and other recreationists. The proposed project is part of the Bridge District Specific Plan.	Yes	Transportation
Sacramento River	Yolo	Clear Lake Operations Evaluation Program		During the winter months Cache Creek Dam releases are dictated by the Gopcevic Decree. Yolo County Flood Control and Water Conservation District (FCWCD) and Lake County FCWCD have discussed the possibility of modifying these operational rules under certain conditions to benefit both Yolo and Lake County interests. These changes could be coupled with some physical modifications at the Grigsby Riffle. These actions could potentially reduce peak flood flows in Cache Creek by about 4,000 cfs on the levees near Woodland, while also providing flood relief to Clear Lake residents. Additionally, reoperations of the Cache Creek Dam could provide a significant amount of water supply in certain hydrologic year types.	Yes	Water Supply
Sacramento River	Yolo	Deep Water Ship Channel Navigation Levee Repair		Correct deficiencies, protect against under seepage, and maintain the Deep Water Ship Canal Levees to current standards for FEMA 100-year and urban levee 200-year levels of flood protection. Physical improvements may include, but not be limited to, restoration and armoring of water-side levee slopes, increased levee height through crown raising or crown-top walls, slurry cutoff walls in the levee prism, seepage blankets on the levee land-side, levee setbacks, etc	Yes	Transportation
Sacramento River	Yolo	Knaggs Ranch Acquisition	$15,107,500	The project consists of the purchase of the 2,622-acre Knaggs Ranch property and its preservation for agricultural conservation, flood protection, and wildlife habitat. Project would prevent development on 30% of Elkhorn Basin adjacent to Central Valley Flood Control Project levees, which are part of an important floodwater retention and conveyance system. With land on the other side of the Sacramento River rapidly urbanizing, protection of this site provides an important relatively undeveloped area that might flood during extreme flood events releasing pressure on other parts of the flood control system possibly preventing the flooding of nearby urban areas such as the Natomas area. The site provides habitat of statewide importance for the Federal and State-listed giant garter snake (Threatened), the State-listed Swainson's hawk (Threatened), wintering waterfowl, Sacramento Splittail, and Chinook salmon. The site includes 850 acres within the Yolo Bypass.	Yes	Ecosystem
Sacramento River	Yolo	Yolo and Tisdale Bypasses Sediment Removal Program		Remove sediment that is restricting the capacity of the Yolo Bypass and the Tisdale Bypass.	Yes	Water Quality
San Francisco Bay	Alameda	Crow Creek Fish Habitat Restoration	$1,000,000		Yes	Ecosystem
San Francisco Bay	Alameda	Flood Facilities - Chain of Lakes	$23,350,000	The Chain of Lakes are located between the cities of Livermore and Pleasanton and, when complete, will consist of a series of abandoned gravel quarry pits converted into nine lakes, linked in a series, plus Cope Lake. Thus far the County owns two of these lakes, and will acquire one around 2014 and two more by 2030. The lakes are used for seasonal water storage and conveyance, and floodwater detention.	Yes	Water Supply
San Francisco Bay	Alameda	Major Fish Passage Barrier Removals: Don Castro, Foothill Fish Ladders, Resting Pools	$7,000,000		Yes	Ecosystem
San Francisco Bay	Alameda	San Lorenzo Creek Parkways - Mission to Meek Demonstration Project with Fish Passage Enhancements	$7,000,000	The San Lorenzo Creek Restoration Project is a pilot for a proposed pedestrian and bicycle trail along one of the largest creeks in the East Bay. A 40-foot-deep by 150-foot-wide stream gorge in downtown Hayward is the site of this successful creek restoration. The County's Flood Control District stabilized more than 400 feet of stream bank, constructed three trailheads with creek overlooks, installed ten interpretive panels and banners, and enhanced more than a thousand feet of creekside habitat. If the long-term vision of creating a 12-mile urban creek and trail system is realized, this project will be the centerpiece, providing a scenic rest stop and entry point. This trail system would connect the San Francisco Bay Trail on the western edge of San Lorenzo to the Bay Area Ridge Trail on the Eastern edge of Castro Valley and provide unique recreational opportunities for residents.	Yes	Recreation
San Francisco Bay	Alameda	Tidal Wetlands Restoration for Sediment Management	$20,000,000		Yes	Ecosystem
San Francisco Bay	Alameda	Zone 2 Line B, Fish Ladder Construction at San Lorenzo Creek Dam in Unincorporated Hayward	$660,000		Yes	Ecosystem
San Francisco Bay	Alameda	Zone 2 Line J, Creek Restoration Between Norbridge Avenue and East Castro Valley Boulevard in Castro Valley	$265,000	The primary purpose of the project was to increase the creek's capacity to carry a 100-year flood. Project includes daylighting a stretch of Castro Valley Creek near Norbridge Avenue and Redwood Road, demolishing a 300-foot-long by 12-foot-wide by 6-foot-high concrete box culvert, widening creek banks, installing a creekside amphitheater, recreational trails, and a playground.	Yes	Recreation
San Francisco Bay	Alameda	Zone 3A, Line A between Confluence Union Pacific Railroad and Cabot Boulevard	$1,400,000	This project will provide the best overall solution meeting District's design criteria including bank stabilization, reduction of flow velocities, and containment of the 100-year storm event. The project will restore the project site by planting native vegetation within the constraints of right of way and design parameters.	Yes	Ecosystem
San Francisco Bay	Alameda	Zone 5 Shoreline Levee Construct In-board Levee between Old and New Alameda Creeks, Union City	$8,310,000	As part of the salt pond project coalition, the District is helping to restore approximately 5,500 acres of Eden Landing Ponds in Hayward, and has provided the design for restoration. Existing salt pond levees and dikes will be removed to allow water to flow naturally in and out of the low-lying wetlands. The District has also conducted studies to learn more about Bay tidal effects on the ponds, and how old Alameda Creek and the Alameda Creek Federal project will be integrated with the creation of new wetlands.	Yes	Ecosystem
San Francisco Bay	Contra Costa	Lower Walnut Creek Improvements	$28,000,000	Master plan enhancement followed by restoration, levee setback, sediment removal to clear portion of channel, acquisition of adjacent wetland for salt marsh harvest mouse and trails adjacent to creek. Studies with the USACE are ongoing. Work has been completed on a $260,000 CALFED grant - study grant. The Lower Walnut Creek Project incorporates a new way of approaching the traditional methods of operating and maintaining a flood control facility. The existing channel is a classic USACE trapezoidal earth channel that requires ongoing de-silting maintenance. The alternative approach will be to move the channel levees back in the lower reaches to provide additional capacity for floodwaters and to create floodplains. This approach will provide the necessary capacity to handle floodwaters while reducing de-silting costs and creating additional wetlands, riparian habitat and revegetation potential. Other project components include improving fish passage and habitat and increasing recreational opportunities.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
San Francisco Bay	Contra Costa	Pacheco Marsh Restoration	$10,900,000		Yes	Ecosystem
San Francisco Bay	Contra Costa	Pinn Brothers Marsh Creek Riparian Restoration Project		Working in collaboration with the City of Brentwood, Contra Costa County FCWCD and NHI, the Pinn Brothers developers plan to restore a floodplain and riparian vegetation along 1,900 linear feet of Marsh Creek as part of a 579-unit subdivision development on 79 acres in downtown Brentwood. This project is the longest stretch of undeveloped land adjacent to Marsh Creek in the City of Brentwood. This project will expand the Marsh Creek channel, creating enough room to restore riparian vegetation while maintaining the 100-year flood conveyance capacity. Riparian vegetation will provide habitat for birds, shade for the residents who use the adjacent trail, and lower the temperature in the creek to improve habitat for aquatic species such as the endangered red-legged frog, western pond turtle and spawning fall-run Chinook salmon.	Yes	Ecosystem
San Francisco Bay	Marin	Bothin Marsh/Coyote Creek Restoration and Flood Control	$3,000,000	The project will increase tidal prism by opening the levee between Coyote Creek and the Marsh and restore marsh habitat within the Bothin Marsh Open Space Preserve. It is also desired to increase the size of the Marsh area for stormwater absorption and increased tidal prism. The project will be designed to improve the value and quality of the habitats within Bothin Marsh. Fill will be excavated to restore marsh plain habitat; this will provide additional marsh habitat suitable for both the salt marsh harvest mouse and Point Reyes bird's beak. Also upland cover will be enhanced to provide upland refuge for clapper rails. The entire program would entail a joint planning, acquisition, construction and restoration project administered by the Marin County FCWCD in participation with County Parks and Open Space Department.	Yes	Ecosystem
San Francisco Bay	Marin	Channel Maintenance Dredging--Gallinas Creek		Maintenance dredging project of Las Gallinas Creek for recreational/boating use to minus 7 feet.	Yes	Recreation
San Francisco Bay	Marin	Community Service Area 29 Paradise Cay Maintenance Dredge	$500,000	Maintenance dredging project that includes the north and south areas of Paradise Cay for recreational boating use to minus 7 feet within waterways and to minus 8 feet in the two entry channels.	Yes	Recreation
San Francisco Bay	Marin	Corte Madera Creek Unit 4 Zone 9	$265,000	Replace the fish ladder and revet the banks of Unit 4 in Ross, dependent on Congressional funding	Yes	Ecosystem
San Francisco Bay	Marin	Corte Madera Creek/Ross Creek Critical Reach		This project will include, at a minimum, removal of the existing timber bulkhead/fish ladder at the concrete channel inlet, construction of a smooth transition from the natural channel to the narrow concrete channel inlet, and other measures to enlarge the channel. The USACE design is also anticipated to include top-of-bank floodwalls or landscape berms upstream and downstream of the fish ladder to contain floodwaters. This project will seek to accommodate a peak discharge up to 5,000 cfs at the lower Sir Francis Drake Boulevard Bridge and up to 6,000 cfs (but no less than 5,600 cfs) at the Ross Creek confluence. Measures that lower water levels under design discharge conditions by improving the hydraulic efficiency of the channel should be incorporated into the Unit 4 Project design. These measures, which are located upstream of the stream flow-gauge in Ross, also improve the natural and ecological functions of the creek (biotechnical bank stabilization, enlarging and restoring creek, restoring slope bank and bed).	Yes	Ecosystem
San Francisco Bay	Marin	Lower Las Gallinas and Miller Creek Restoration Proposal	$52,000,000	The Las Gallinas-Miller Creek wetland complex (7 square miles) supports a significant area of mudflats in San Pablo Bay. These tidal marshes support the largest population of Clapper Rails in the North Bay region and Miller Creek supports a small but self-sustaining run of genetically unique steelhead trout. This proposal integrates wetland restoration with flood management benefits, including levee rehabilitation, local drainage improvements, and channel dredging.	Yes	Ecosystem
San Francisco Bay	Marin	Lower Novato Creek Restoration Proposal	$12,200,000	The proposed tidal marsh restoration at Bel Marin Keys will affect the hydrology of several elements within the lower Novato Creek basin. Proposed modifications to Pacheco Pond and the proposed diversion of flow away from Novato Creek considered in the design alternatives will present the most substantial effects. The proposed modifications to Pacheco Pond consist of either expanding the existing pond, or creating a seasonal marsh adjacent to the pond. In addition, the diversion of water currently flowing into Novato Creek from Pacheco Pond, to the proposed tidal marsh will greatly affect existing conditions on the Bel Marin Keys tidal wetlands restoration site. These flows will provide fresh water for the proposed freshwater marsh portion of the project.	Yes	Ecosystem
San Francisco Bay	Marin	Phoenix Lake Detention Basin	$3,700,000	Primarily for the purpose of water supply reserve for use during the dry season, particularly during shortages, but also serves as wildlife habitat and a public recreation and enjoyment area.	Yes	Ecosystem
San Francisco Bay	Marin	Phoenix Lake Integrated Regional Water Management Retrofit	$7,661,000	The Phoenix Lake IRWM Retrofit is a multipurpose proposal composed of five component projects, all located at Phoenix Lake: Flood Damage Reduction; Water Supply; Water Quality; Ecosystem Restoration; and Recreation and Public Access. By seismically retrofitting the dam and constructing other improvements to the hydraulic and recreational infrastructures of the lake, thus can be operated to serve multiple purposes of flood control, drinking water supply, water quality, ecosystem restoration, and public recreation. Therefore, the Retrofit meets the 6 regional goals and 62 objectives of the Bay Area IRWM Plan.	Yes	Water Supply
San Francisco Bay	Marin	Regional Best Management Practices, Field Manual, and Training for Stream Maintenance Activities	$130,000	The purpose of this project is to create an integrated set of regional BMPs, a standardized field manual, and consistent training for stream maintenance activities. Regionally consistent materials will help maintain flood capacity, while contributing to habitat protection and water quality.	Yes	Ecosystem
San Francisco Bay	Marin	Salt Marsh Enhancement and Tidal Prism Enlargement		Three measures to manage sedimentation and maintain 100-year capacity in the earthen channel: (1) raise levees along the 2,000-foot-long 100-year bankfull reach below the stilling basin; (2) scour the channel by enlarging the tidal prism; and (3) conduct periodic dredging. Five potential sites were preliminarily identified in the adjacent floodplain of the earthen channel for marsh enhancement and tidal prism enlargement	Yes	Water Quality
San Francisco Bay	Marin	Sleepy Hollow Creek Channel Improvements	$9,100,000	For Sleepy Hollow Creek, the Capital Improvement Plan Study calls for 33 in-channel capacity measures. Key measures include: (1) replacing the Taylor, Mountain View, Morningside, and Broadmoor Avenue Bridges; and associated channel enlargement and creek restoration work, and (2) enlarging the channel and restoring the creek at two additional sites downstream of the Morningside Avenue Bridge and the Broadmoor Avenue Bridge.	Yes	Transportation
San Francisco Bay	Marin	Wetland and Creek Restoration at Big Lagoon, Muir Beach	$2,500,000	The project involves three components: (1) ecological restoration, (2) public access upgrades, including a reconfiguration of the existing parking lot, and (3) replacement of the Pacific Way Bridge. All components are designed to improve ecological function.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
San Francisco Bay	Napa	Napa River - Rutherford Reach Restoration	$17,800,000	Restoration objectives for the Rutherford Reach of the Napa River include the following: 1. Reduce bank erosion, loss of vineyard land, and flood damages by restoring stability to the Napa River 2. Reduce sediment loading into the river downstream and into San Pablo Bay (a Regional Water Quality Control Board TMDL objective) 3. Restore habitat for salmonids and other aquatic species including existing runs of steelhead trout and Chinook salmon, by creating more riffles, reducing sediment burial of spawning gravels, and increasing cover and shade 4. Restore a continuous corridor of riparian habitat for birds and wildlife 5. Replace invasive plants with native species and reduce risk of Pierce's disease 6. Engage landowners in the process and maintain regulatory compliance	Yes	Ecosystem
San Francisco Bay	San Mateo	Colma Creek Flood Control and Habitat Mitigation Improvements		The Colma Creek Flood Control Channel provides flood protection for residents of South San Francisco, Colma and Daly City. Loss of salt marsh wetland habitat caused by flood control channel improvements are being mitigated by restoring 1.5 acres of salt marsh wetlands and 2 acres of high-quality upland habitat located at the outlet of Colma Creek to San Francisco Bay. Funding is sought to complete three projects on the Colma Creek Flood Control Channel. One project would install a sheetpile wall on the south side of the Colma Creek Channel from Utah Avenue to Navigable Slough to provide enhanced flood protection at the lower reaches of the Channel. A second project would provide for continued maintenance and monitoring at the habitat mitigation site located along the creek banks near San Francisco Bay. A third project would develop and implement a trash management program aimed at reducing the amount of trash entering the flood control channel from adjacent and upstream communities.	Yes	Ecosystem
San Francisco Bay	San Mateo	Sanchez/Terrace Creek Restoration Project	$10,000,000	Repair eroded channel, stabilize banks and levees, remove sedimentation, improve catch basins and storm drain pipes in the Laguna Avenue residential area. Improve channel conveyance capacity by increasing the size of the Terrace Creek box culvert from Laguna Avenue to California Drive, by installing a new pump station and force main in the vicinity of Carolan Avenue, and by installing a debris basin upstream from Carolan Avenue. Improve the benefits to the creek eco system	Yes	Water Quality
San Francisco Bay	San Mateo	Streambank Stabilization Using Bio-engineering		Project will demonstrate and improve use of bio-engineering techniques on eroding sections of Pescadero Creek, Tunitas Creek, Purisima Creek, and Lobitos Creek, located in unincorporated San Mateo County. The targeted eroding creek banks are located adjacent to county-maintained roads and within county rights-of-way. These creeks are designated as critical habitat for steelhead trout by the National Marine Fisheries Service. Grant funds will be used to train engineering staff and road crews, design site-specific bioengineered projects, permitting, construction, and monitoring.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Alviso Slough Restoration Project	$16,500,000	Objectives include: (1) restore Alviso Slough's channel width and habitat to prior to 1983 conditions; (2) improve the community's ability to pursue navigation, public access, and aesthetics to allow for the expansion of boating and other recreational and/or tourism opportunities; (3) maintain 1 percent flood protection in Alviso Slough; (4) reduce mosquito nuisance; and (5) promote the integration of the Alviso Slough Restoration Project with the South Bay Salt Pond (SBSP) Restoration Project (including the SBSP Phase 1 Action at Pond A8) to reestablish the saltwater connection to the Lower Guadalupe River.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Guadalupe River Downtown Flood Protection (from Interstate 880 to Interstate 280)		The Guadalupe River Flood Protection Project extends from Interstate 880 to Interstate 280 in the City of San Jose. The project will provide flood protection to the city's technology and commercial industries and established residential neighborhoods, protect and improve the water quality of the river, preserve and enhance the river's habitat, fish, and wildlife, and provide recreational and open space benefits.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Lower Silver Creek Flood Protection Project	$50,000,000	The project will enlarge the creek channel and requires the replacement or enlargement of existing bridges crossing the creek. Project will protect nearly 3,800 homes and businesses from a 100-year flood event. Project objectives include: (1) provide flood protection from a 100-year flood event from Coyote Creek to Cunningham Avenue; (2) protect 3,800 homes and businesses from a 100-year flood event; (3) prevent potential future flooding damages from a 100-year flood event; (3) enhance native riparian and environmental habitat; (4) improve creek maintenance; (5) improve water quality; (6) provide increased opportunities for recreation in cooperation with the city and county.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Lower Silver Creek, I-680 to Cunningham (Reach 4-6)	$65,334,000	This project is part of a flood control project that partners with the Natural Resource Conservation Service (NRCS) to plan, design and construct improvements along approximately 2.3 miles of Lower Silver Creek, from Interstate 680 to Lake Cunningham. This project includes elements that are eligible for reimbursement from the State and Federal governments to accomplish the following objectives: Increase flood protection to 5,400 properties in the surrounding area. Improve vehicle and pedestrian bridges crossing Lower Silver Creek. Allow for onsite mitigation of project impacts, and in some cases enhancement of existing habitat values by increased wetlands and riparian habitat.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Mid-Coyote Project	$32,000,000	The Mid Coyote Project is located in the central portion of the Coyote Watershed. Its limits extend approximately 6.1 miles between Montague Expressway and I-280, all in the City of San Jose. The project's primary objective is to enhance the creek's conveyance. Additionally, the project will improve fisheries and habitat values and provide appropriate public access opportunities in cooperation with the City of San Jose. This multi-year study will necessitate preparation of a detailed Engineer's Report and an Environmental Impact Report to comply with CEQA.	Yes	Ecosystem
San Francisco Bay	Santa Clara	Open Space Authority Acquisitions		Preservation of wetlands and riparian corridors will also help reduce flood peaks	Yes	Ecosystem
Central Coast	Santa Clara	Restoration of the Upper Pajaro River Floodplain		Develop a plan for restoration of a wildlife corridor that will also preserve undeveloped land valuable for flood attenuation.	Yes	Ecosystem
San Francisco Bay	Santa Clara	San Francisco Bay Shoreline	$500,000,000	San Francisco Bay Shoreline is a partially-funded (planning phase only) project that provides district coordination with the California Coastal Conservancy, USACE, and other project partners to plan, design, and construct improvements to accomplish the following objectives: provide integrated fluvial and tidal flood protection; restore and/or enhance tidal marsh and related habitats; provide recreational and public access opportunities throughout the tidal floodplain of Santa Clara County; and pursue continued Federal funding.	Yes	Ecosystem
San Francisco Bay	Santa Clara	San Tomas Creek, Quito Road Bridges Replacement	$558,000	This project funds the town's portion of the replacement cost for two bridges on Quito Road to improve roadway safety and provide adequate stormwater flow capacity in the creek under the bridge.	Yes	Transportation
San Francisco Bay	Santa Clara	South Bay Salt Pond Restoration Project		The goals of the project are to restore and enhance a mix of wetland habitats, provide wildlife-oriented public access and recreation, and provide for flood management in the South Bay.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
San Francisco Bay	Santa Clara	Sunnyvale and East and West Channels	$50,300,000	Sunnyvale East and West Channels Improvement project plans, designs, and constructs improvements to approximately 6.4 miles of the Sunnyvale East Channel, from Guadalupe Slough to Interstate 280, and 2.3 miles of the Sunnyvale West Channel, from Guadalupe Slough to Highway 101. This project will provide flood protection to 1,629 parcels; provide environmental enhancement benefits where opportunities exist; provide recreation enhancements where opportunities exist; reduce erosion, sedimentation, and maintenance costs; and protect fish and wildlife habitat.	Yes	Water Quality
San Francisco Bay	Santa Clara	Thompson Creek Stream Stabilization	$2,500,000	Work along the riparian corridor will enhance habitat by rehabilitating potentially thousands of feet of currently concrete channels back to partial riparian channels.	Yes	Ecosystem
San Francisco Bay	Solano	Alamo Creek Detention Basin	$5,920,000	This project would include the establishment of a 1,000-acre-foot detention basin upstream from the City of Vacaville. The detention basin would hold 1,000 acre-feet of floodwater when flows exceed 500 cfs. Water would flow in and out of the basin by gravity (i.e., no pumps will be required). The frequency of flooding along Alamo Creek will be reduced from 1 in 3 to 5 years to about 1 in 28 years. Within the detention basin 1 acre of wetland habitat would be created. There would be a reduction in sediment loads and downstream erosion.	Yes	Ecosystem
San Francisco Bay	Solano	Cache Slough/Yolo Bypass Mitigation Area, Solano County, California, Office Report, Sacramento River Bank Protection Project		The Sacramento River Bank Protection Project (SRBPP) is a continuing construction project, authorized by the Flood Control Act of 1960, to provide protection for the existing levees and flood control facilities of the Sacramento River Flood Control Project. The Cache Slough/Yolo Bypass mitigation site is very similar to the Prospect Island study. For this site, a cross levee was constructed to isolate the southern tip of Liberty Island from the northern portion of the island. Two mounds were created in the interior of the island, and then the levees of the isolated tip were breached in two places to restore tidal action to the site. This report evaluated different combinations of the habitat variables (such as topography, planting, and type of levee breach) of the mitigation site to determine the habitat value that could be realized by each combination.	Yes	Ecosystem
San Francisco Bay	Sonoma	Baylands		The project site offers a unique opportunity to restore nearly 1,000 acres of historic tidal marsh habitat that will benefit the Baylands ecosystem and endangered species, and provide Bay Area communities with improved water quality, flood protection and recreation. The Sonoma Land Trust has acquired the property	Yes	Ecosystem
San Joaquin River	Amador	Off-Stream Storage on Consumes River	$40,000,000	A combination flood control and surface water supply project will provide both a reliable water supply and some flood control for these areas. Rather than on-stream storage and a dam, this project will focus on off-stream storage. High river flows will be reduced as surplus water is diverted and stored for use during dry periods.	Yes	Water Supply
San Joaquin River	Amador	Bear River Reservoir Expansion Project	$44,000,000	There are three alternatives for this project that are being considered. The alternatives are: (1) raise the Lower Bear Dam by 32 feet, increasing storage capacity by 26,407 acre-feet; (2) replace the Upper Bear Dam with a new dam; or (3) construct a new dam on Cole Creek. While the primary benefit is additional water supply for Amador and Calaveras Counties through increased storage of winter flows, other benefits include flood control, power generation, improved water quality, and cold water releases to improve fisheries.	Yes	Water Supply
San Joaquin River	Calaveras	Off-Stream Storage on Mokelumne and Calaveras Rivers Project Summary	$155,276	The Off-Stream Storage on Mokelumne River is Phase I and Off-Stream Storage on Calaveras River is Phase II of the project. Phase II may begin upon completion of Phase I or occur simultaneously. This project proposes to store surplus winter flows in the Mokelumne River. High flow discharges will be captured for distribution during the peak water use season. A study will be performed to identify and evaluate site-specific characteristics for potential off-stream storage reservoir locations. The Calaveras River flow is derived from rainfall with almost no contribution from snowmelt. A study will be performed to identify and evaluate locations for off-stream storage reservoirs to take advantage of surplus flows.	Yes	Water Supply
San Joaquin River	Calaveras	Calaveras River Watershed Implementation Plan	$325,000	Continual overdraft and contamination of this critically overdrafted groundwater basin has created a need to identify new surface water sources. The Watershed Implementation Plan will include a list of management strategies that will address multiple issues in the watershed, including, but not limited to, the need for water quality improvements for drinking water and other beneficial uses, water supply reliability, pollution prevention, and aquatic and terrestrial habitat restoration; and the steps necessary to implement each management strategy.	Yes	Water Supply
San Joaquin River	Calaveras	Cosgrove Creek Project	$5,000,000	To provide flood control protection along Cosgrove Creek in these areas as well as surface water storage, recreation, environmental restoration, and wastewater recycling, a series of facilities will be constructed. A weir to attenuate the flashy Cosgrove Creek flood flows. The weir will be built across the creek with off-stream storage on New Hogan Dam Road, just south of Valley Springs, putting diverted water to beneficial use. It will reduce peak flows from 3,800 cfs to 3,000 cfs that currently impact over 400 people and over 100 structures, in this 100-year floodplain. A pedestrian/bike path along Cosgrove Creek will also be included with the project to connect the La Contenta area to the Valley Springs area. Recreational fields, including soccer and baseball fields, will also be constructed in the inundation area. The fields will be irrigated with recycled tertiary treated wastewater from CCWD's La Cantata WTP. Vernal pools will be implemented along the creek, contributing to riparian restoration in the area. The addition of vernal pools will diversify the surrounding habitat and species, moderate seasonal flooding during storm events, and like wetlands, remove contaminants from agricultural and urban runoff. Trails coupled with tours and pamphlets will also be implemented as an opportunity to contribute to public education.	Yes	Water Supply
San Joaquin	Calaveras	Upper Mokelumne River Watershed Management Plan	$1,250,000	A complete watershed management plan is needed that will integrate much of the water quality management plan information into a comprehensive watershed management plan for the Upper Mokelumne River watershed. This document will help direct future watershed restoration and land use policies within the region by prioritizing restoration needs, resource conservation strategies and projects, and adoption of local and regional land use policies designed to provide a comprehensive management plan for the Upper Mokelumne River watershed resources.	Yes	Water Quality

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
San Joaquin River	Contra Costa	Dutch Slough Tidal Marsh Restoration		The Dutch Slough Tidal Marsh restoration project is located at the mouth of Marsh Creek in northeast Contra Costa County. The project will restore 1,266 acres of wetland and upland habitats including tidal marsh, oak woodland, Antioch dune scrub, and shaded riverine riparian. Phase 1 entails excavating approximately 750,000 cubic yards of material on Ironhouse Sanitary District lands immediately west of the Marsh Creek flood control channel to create 100 acres of tidal marsh and riparian habitat at the mouth of Marsh Creek while cost-effectively providing fill material necessary to prepare the 1,166 Dutch Slough site east of Marsh Creek for tidal marsh restoration. Fill material from the Iron House Sanitary District (IHSD) lands will be used to bolster interior levees and elevate subsided areas in preparation for tidal marsh restoration at DWR's Dutch Slough project site. After excavation, the 100-acre IHSD site west of Marsh Creek will be restored to a tidal marsh and riparian habitat zone especially designed to enhance the functionality of the Marsh Creek flood control channel and to biofilter polluted water emanating from the Marsh Creek watershed. The biofiltration wetland will reduce pollutants entering the Dutch Slough site and the Delta and thereby help protect the region's water quality source from degradation by non point run-off.	Yes	Ecosystem
San Joaquin River	Contra Costa	East Antioch Creek Marsh Restoration Project		This project is located in the lower reach of East Antioch Creek between the San Joaquin River and Lake Alhambra. The reservoir rehabilitation will be conducted in two phases and has three identified goals: enhanced marsh expansion and restoration, increased tidal and storm flow capacity, and establishment of community-based conservation through public education and outreach programs.	Yes	Ecosystem
San Joaquin River	Contra Costa	Knightsen Wetland Biofilter	$2,815,000		Yes	Water Quality
San Joaquin River	Contra Costa	Marsh Creek Drop Fish Passage Improvement	$146,000		Yes	Ecosystem
San Joaquin River	Fresno	Temperance Flat Dam	$33,000,000	Increase storage capacity, It would provide 1,200,000 acre-feet of storage and an additional 160,000 acre-feet of usable annual water	Yes	Ecosystem, Water Quality, Water Supply
San Joaquin River	Madera	Ash Slough Arundo Eradication and Sand Removal Project	$1,922,810	This project involves the eradication of *Arundo donax*, a non-native invasive bamboo, from critical portions of Ash Slough. Arundo blocks flood flows in the Slough and causes flood hazards, as well as fire hazards, habitat deterioration and excessive evapotranspiration of water that could be used to recharge the overdrafted groundwater. The targeted area has been selected to prevent levee failure and flooding of the City of Chowchilla. As part of this project, the County will also obtain the required permits for sediment removal from the channel. This will provide additional increased flood flow capacity. Arundo utilizes up-to 20 times more water as the native grasses which will be used to re-vegetate the cleared areas. This is water that would otherwise either percolate through the sandy soils to recharge the groundwater, be used for agricultural purposes, or flow down the Eastside Bypass into the San Joaquin River delta.	Yes	Ecosystem
San Joaquin River	Madera	Cottonwood, Dry and Berenda Creek Arundo Eradication and Sand Removal Project	$2,184,531	There is potential for flooding on Cottonwood Creek, Dry Creek, and Berenda Creek due to invasive plant species, particularly Arundo, overgrown vegetation, and sedimentation which lead to a lack of channel capacity. Without proper capacity, these channels are unable to carry the design flows or flood flows. Objectives of the project include: (1) to improve flood flows in Madera County, specifically on property, both industrial and agricultural, along Cottonwood Creek, Dry Creek and Berenda Creek; (2) to improve Madera County's economic viability by reducing the potential for flood flows; (3) to increase water availability in Madera County by reducing unnecessary evapotranspiration from *Arundo Donax* infestation; (4) to improve wildlife habitat in Madera County along Cottonwood Creek, Dry Creek and Berenda Creek by eradicating *Arundo Donax*, an invasive exotic plant, and by removing excess sedimentation; (5) to improve Madera Irrigation District's ability to deliver water to its users without capacity constraints; (6) to provide Madera Irrigation District's growers greater flexibility in managing their water, thus improving overall irrigation efficiency and use; (7) eradicate *Arundo Donax* from 32 miles of creeks and an area of approximately 300 acres; (8) remove 25,000 tons of sand from 32 miles of creek bottom.	Yes	Ecosystem
San Joaquin River	Madera	Madera Ranchos Flood Control and Water Recharge Ponding Basin	$2,233,950	The project is a ponding basin to be located adjacent to the Madera Canal at the Southeast corner of Avenue 12 and Road 38, east of the Madera Ranchos community. The ponding basin will be a large pond which can be used for overflow of floodwaters to prevent the flooding of the Madera Ranchos community. Floodwaters will be held in the pond until they percolate into the ground, recharging the overdrafted groundwater in that area. Project Goals are (1) develop a project that will prevent flooding of the Madera Ranchos community from 100-year flood events; (2) increase groundwater recharge in the area; and (3) create a 120-acre-foot detention basin for flood control and groundwater recharge.	Yes	Water Supply
San Joaquin River	San Joaquin	Budlisilich Fish Passage Improvements	$350,000	Flashboard dam which was barrier for fish. SEWD agreed to make improvements as part of Anadromous Fish Program from the Department of Fish and Wildlife. Project is more than 50% complete.	Yes	Ecosystem
San Joaquin River	San Joaquin	Farmington Groundwater Recharge and Seasonal Habitat Program	$33,500,000	The objective of the Farmington Groundwater Recharge Program is to recharge an average of 35,000 acre-feet of water annually into the Eastern San Joaquin Basin. The recharge method of choice is field-flooding, a practice where a small perimeter levee is built at the parcel, then flooded to a depth of up to 18 inches.	Yes	Water Supply
San Joaquin River	San Joaquin	Gill Creek and Woodbridge Rood Flood Control Improvements	$25,000,000	In 2004, the San Joaquin County Department of Public Works Stormwater Management Division completed the Gill Creek and Woodbridge Road Watersheds Reconnaissance Study (Gill Creek Study) to identify and recommend a project that would provide a 100-year level of protection to structures and a 25-year level of protection to agriculture in the study area. The Gill Creek Study explored three alternatives with the following focuses: channel enlargement, detention, and diversion into the Lower Mokelumne River. The Gill Creek Study identified detention as the preferred alternative, which includes minor channel improvements and the construction of up to 15 detention basins covering a total area of 65 acres spread throughout the watersheds. The preferred alternative also has the potential to provide addition benefits because the channels and detention basins could be used to convey Mokelumne River Water for irrigation and direct recharge. The North San Joaquin Water Conservation District (NSJWCD) owns an existing 30 cfs irrigation system near Tretheway Road extending west along Acampo Road. Improvements to the NSJWCD North Irrigation System or an additional system could serve the conjunctive water management needs of the area. The next step is to perform a feasibility study where the conjunctive use and flood control operation can be explored further and the benefits quantified.	Yes	Water Supply
San Joaquin River	San Joaquin	Lower San Joaquin River Flood Bypass	$6,125,000	Increase flood conveyance capacity through a constrained reach of the San Joaquin River floodway by acquiring easements and fee title to expand Paradise Cut Bypass. The project will also provide floodplain and riparian habitat for sensitive species including riparian brush rabbit, giant garter snake, Sacramento splittail and juvenile Chinook salmon. The project would reduce flood stage in mainstem San Joaquin River between Vernalis and Stockton and reduce the likelihood of levee failure on the San Joaquin River in Lathrop, Manteca and Stockton areas.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
San Joaquin River	San Joaquin	MORE Water Project	$412,000,000	The MORE WATER Project could potentially bring 60,000 to 100,000 acre-feet per year to the Basin. The MORE WATER Project is planned to consist of three infrastructure projects: the MORE WATER Duck Creek Reservoir, the MORE WATER Lower Mokelumne Diversions, and the MORE WATER Storage Plus Direct Diversions Project. Lower Mokelumne Diversions: The MORE WATER Project and water right application is also seeking one or more diversions from the lower Mokelumne River. The diversions would be located along the Mokelumne River between Camanche Reservoir and Interstate 5. Herein, up to 620 cfs would be diverted from the river at structural or nonstructural intakes. Diverted water would include only surplus spills from Camanche Reservoir, including flood flows. Under either alternative, water would be transported to the Stockton area via pipeline and Watershed Improvement District canals. Water would then be utilized during the December through June period for direct or in-lieu groundwater recharge. This project would supply an average of up to approximately 43,000 AF/yr during December through June. Water Storage Plus Direct Diversions: Water would be diverted from the southern end of Pardee Reservoir, which is located on the Mokelumne River. Diverted water would be routed into a gravity-feed tunnel/pipeline that would discharge into Duck Creek, which is a tributary to the Calaveras River. In the event that Duck Creek Reservoir is not built, water would be diverted from the Calaveras River downstream of its confluence with Duck Creek. If Duck Creek Reservoir is approved and completed, water diverted from Pardee Reservoir would instead flow into the Duck Creek Reservoir. From that point it would be transported, via pipeline, to agricultural users, groundwater recharge facilities, or other users, or routed into spreading and recharge basins. The project would supply up to an average 67,000 acre-feet per year at a maximum diversion rate of 1,000 cfs. Diversion would occur only during flooding and other high-flow periods, or in anticipation of flooding event. Duck Creek Reservoir: The proposed Duck Creek Reservoir is an approximately 150,000 af capacity off-stream reservoir located in eastern San Joaquin County. The Duck Creek watershed drains into the Calaveras River at the divergence of the Calaveras River and Mormon Slough at Bellota. The Duck Creek dam system would consists of a 6000' earthen main dam at the south end and a series of smaller saddle dams to the west. Water would be diverted at either Pardee Reservoir or Camanche Reservoir for storage in Duck Creek Reservoir. The water right application seeks to divert up to 1,000 cfs to storage and 620 cfs by direct diversion. The total maximum diversion capacity is 1,620 cfs from either Pardee or Camanche Reservoirs. Water diverted from Pardee Reservoir at a rate of 1,620 cfs would require a diversion structure and tunnel. Regulated releases from Bellota would be rediverted to the SEWD water Treatment Plant, Mormon Slough, Potter Creek, Mosher Slough, the Lower Calaveras River, and potentially the proposed Alliance Canal for beneficial use or direct groundwater recharge.	Yes	Water Supply
San Joaquin River	San Joaquin	Re-Operation of New Hogan Reservoir for Flood Control		This combination of options suggests that average annual deliveries to SEWD could be increased by about 25,000 acre-feet by maximizing the available supplies from New Hogan Reservoir. The reservoir is currently operated to save a certain amount of carryover storage each year; however, the carryover requirement limits the amount of storage available in wet years. All of the carryover storage water can be used in each year by farmers who currently use groundwater for irrigation. This in-lieu recharge would result in an increase of groundwater storage that could be used during dry years. Thus, this option effectively moves carryover storage from the reservoir into the groundwater basin. If the reservoir is fully emptied before the rainy season begins, then the reservoir could capture additional flows during wet years.	Yes	Water Supply
San Joaquin River	Stanislaus	Big Bend Floodplain Protection and Restoration Project (Formerly Todd-Venn)	$2,605,619	The project is located in eastern Stanislaus County approximately 5.5 miles west of the City of Modesto. The project proposes to acquire fee title to and perpetual conservation easements on approximately 167 acres and restore approximately 223 acres of the Tuolumne River floodplain. The enhanced area provides for flood damage reduction by facilitating, enlarging, and returning natural fluvial processes to the floodplain. In addition, the restored riparian corridor and its associated shaded riverine aquatic habitat that extends approximately 2 miles on the south side of the river and 1 mile on the north side of the river will provide enhanced habitat for a variety of fish and wildlife species.	Yes	Ecosystem
San Joaquin River	Stanislaus	Ecosystem Restoration & Floodwater Attenuation Project, San Joaquin River.	$3,565,496	This project will benefit the State of California by reducing flood risk liability, enhancing the ecosystem and reducing operation and maintenance costs for flood control facilities on the San Joaquin River. The project improve the connection of 1,535 acres of floodplain to the River by breaching existing levees to reduce fish entrapment and improve transient floodwater storage benefits, and reduce ecosystem damage from water standing for excessive periods.	Yes	Ecosystem
San Joaquin River	Stanislaus	Riddle Surface Mine		Calaveras Materials Inc. (CMI) proposes developing and reclaiming an aggregate (sand and gravel) surface mine and materials processing Plant Complex on two discontiguous sites totaling 436 acres in western Stanislaus County. CMI is proposing to reclaim the site to an agricultural reservoir (as a source of irrigation water to surrounding agricultural uses) and/or a flood detention component of the County's flood control system.	Yes	Water Supply
San Joaquin River	Stanislaus	Vierra Unit Restoration	$1,755,542	The proposed project will involve 511 acres. Levee breaches will be engineered and constructed to minimize erosion, allow water circulation, and minimize fish stranding; wetlands will be restored including grading, water control structures, and a pump and fish screen; riparian woodland will be restored by planting and three years of irrigation and weed control. Federal levee breaching may not occur and USFWS may repair local levees to deal with fish stranding. Project would eliminate the need to repair the local levees and allow area to be opened for flood storage. Wildlife benefit includes conversion of abandoned agricultural fields, now growing exotic weeds, to 200 acres of wetlands and 311 acres of riparian forest.	Yes	Ecosystem
San Joaquin River	Tuolumne	Tuolumne Ditch System Sustainability Project		Development of a Ditch System Sustainability Project (DSSP). The DSSP shall identify the system's values and develop management objectives, tools and maintenance strategies that protect, manage, and enhance the multiple values of the system while improving water delivery. The goal of the project is to sustain the values of the ditch system by developing a comprehensive plan for the management of the system.	Yes	Water Supply
South Coast	Los Angeles	Acquisition of River Channel and Major Tributaries for watershed protection		Acquisition of riparian and floodplain parcels to limit development and preserve habitat function and other watershed benefits.	Yes	Ecosystem
South Coast	Los Angeles	Acton Master Drainage Plan		Phased development of flood control facilities to mitigate flooding in the Acton community. Proposed improvements include four debris basins, five multiple use retention facilities, and low impact water quality enhancement flood control facilities.	Yes	Water Quality
South Coast	Los Angeles	Big Tujunga Wash Mitigation Bank Management	$2,500,000	Big Tujunga Wash Mitigation Bank project encompassed 100-acre site of willow riparian, oak/sycamore woodland and coastal sage scrub terrain overrun with *Arundo* and other non-native plant species. Los Angeles County Department of Public Works, through Chambers Group, engaged Natures Image as landscape construction specialists for this restoration project. This public works project demanded economical use of public funds and a light footprint that would preserve thriving native species while eliminating exotic species that interlaced it.	Yes	Ecosystem
South Coast	Los Angeles	JWPCP Marshland Enhancement Project	$2,637,065	Restoration of vegetation and wildlife habitat value of the 1-acre freshwater Joint Water Pollution Control Plant (JWPCP) marshland that provides stormwater treatment, flood control; project includes educational and recreational facilities.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	Los Angeles	Marina Del Rey and Ballona Creek Feasibility Study Sediment Control Management Plan		This study analyzes the area's hydrology, oceanographic processes, water quality, sediments, biological resources, and economics under existing and future conditions with- and without-project implementation.	Yes	Water Quality
South Coast	Los Angeles	Morris Dam Water Supply Enhancement Project	$13,258,175	Lower the operational pool behind Morris Dam by upgrading the dam's control structures to allow more stormwater to be captured for recharge at downstream spreading grounds	Yes	Water Supply
South Coast	Los Angeles	North Atwater Creek Restoration Project	$5,600,000	This project will construct water quality physical and structural improvements to an area along the Los Angeles River. The project will restore the creek at the North Atwater Park for stormwater runoff capture and treatment and provide wetlands habitat linkage to the Los Angeles River. Two acres of wetland habitat will be created.	Yes	Ecosystem
South Coast	Los Angeles	San Gabriel Dam Browns Gulch Access Bridge	$1,900,000	Project will replace the existing bridge across Browns Gulch on the San Gabriel Dam access road. The existing bridge does not meet current standards.	Yes	Transportation
South Coast	Los Angeles	Tujunga Spreading Grounds Enhancement Project	$24,000,000	Tujunga Spreading Grounds Enhancement Project will improve water supply, water quality, flood control, and open space enhancements, native habitat, and wetlands with passive recreational and educational opportunities.	Yes	Water Supply
South Coast	Los Angeles	Upper Santa Clara River San Francisquito Creek Arundo and Tamarisk Removal Project	$726,500	Restoration of riparian habitat, increased water quantity, improvement of water quality, and reduction of flood and wildfire hazard through the removal of invasive plant species in the Upper Santa Clara River watershed.	Yes	Ecosystem
South Coast	Orange	Aliso Creek Mainstream Restoration Project	$25,000,000	Restoration of a rare coastal stream in Orange County that has been subjected to a variety of degradations. This project will recontour, establish better channel gradient (pools and riffles) by stair-step benching, eliminate non-native vegetation, plant natives, and repair an oxbow meander. Would effectively reestablish riparian wildlife corridor in area of concern. Restoration of corridor on larger scale being envisioned. Also, small coastal zone freshwater wetland would be reestablished.	Yes	Ecosystem
South Coast	Orange	Borrego Canyon Wash Stabilization and Restoration Project	$3,232,000	Borrego Canyon Wash, a tributary of San Diego Creek, drains an area about 5.2 square miles in the upper Newport Bay watershed. It has experienced severe destabilization, including accelerated streambed and bank erosion in recent times. Studies have identified Borrego Wash as the source of approximately half of the sediment discharged to Newport Bay during very wet years. Stream erosion and sedimentation adversely impact water quality beneficial uses of San Diego Creek and Newport Bay, for which a sediment TMDL was adopted in 1998 to address impairment due to excessive sedimentation. To prevent degradation and loss of property and to comply with the sediment TMDL, the County with the aid of the State Water Resources Control Board, completed a feasibility study that provided fluvial modeling and recommended stabilization control measures with conceptual designs. This project will implement the bank stabilization and restoration measures identified in the study.	Yes	Water Quality
South Coast	Orange	Brookhurst Widening Bio-Swale and Synthetic Turf Installation	$1,600,000	This project will use remnant parcels left over from "full takes" of residential properties to create several linear bioswales, which will collect rain and dry weather flows from the curb line via reverse curb drains and will treat and infiltrate these flows, with overflow being released to the storm drain system following treatment. Additionally, drought-tolerant plants along with one-third acre of synthetic turf will be installed to reduce landscape water use.	Yes	Water Quality
South Coast	Orange	Fletcher Basin Rehabilitation	$5,000,000	Fletcher Basin is owned by Orange County Flood Control Division (OCFCD) and was formerly used to impede stormwater flow prior to discharge into the Santa Ana River. Currently, the site is used to dispose of excess soils. This project would convert Fletcher Basin into a recharge basin and make improvements to enhance flood control. This project would include: excavating the basin of excess soils; Cleaning, hauling and disposing of soils; Construction of an influent pipeline and inlet/outlet structure into the basin; Construction of a low-flow channel to route nuisance water directly to the Fletcher Channel; Installation of a pump to evacuate the water into Fletcher Channel in the event of a forecasted storm or for cleaning; construction of improvements to Fletcher Channel (concrete vertical walls) downstream from Fletcher Basin.	Yes	Water Supply
South Coast	Orange	Gobernadora Multi-Use Flood Control Detention Basin Facility	$14,009,085	Proposing to construct the Gobernadora Multipurpose Basin Project (Project) in the South Orange County Watershed Management Area (WMA). The Project will consist of an urban runoff and storm/flood detention basin that will be established as a wetland and riparian habitat, a collection system to capture and divert flows from the constructed wetlands, a pump station and pipeline to connect to the existing Portola Reservoir system. The Basin will be utilized to reduce storm peak flows by flood storage, divert and naturally treat urban runoff and storm flows to 1) reduce downstream erosion and sedimentation, 2) address excessive surface water and groundwater, and 3) improve the water quality in the Gobernadora Creek and San Juan Creek, including the downstream Gobernadora Ecological Restoration Area (GERA).	Yes	Ecosystem
South Coast	Orange	Haster Retarding Basin and Pump Station	$15,677,100	Haster Retarding Basin and Pump Station (C05B02/C05PS1) has over the years experienced flooding in surrounding areas due to flooding of the existing basin and its inability to handle the 100-year peak storm flow. Analysis of the current basin has shown that the basin can only handle the equivalent of a 5-year storm event and needs to be upgraded. Presently, Haster Retarding Basin serves a dual role as a flood control facility and as a community park (Twin Lakes Freedom Park). Regrading the basin and installation of a new pump station is proposed at the Haster Retarding Basin to eliminate flooding of adjacent areas and provide 100-year flood protection. The proposed pump station is intended to be built at the southwest corner of the basin that will also allow existing park uses to continue. The improvements are intended to eliminate basin flooding while maintaining the existing discharge at the downstream outlet to avoid flooding at the Aspenwood	Yes	Recreation
South Coast	Orange	Miraloma Recharge Basin	$6,100,000	The project will consist of a recharge basin, which will be excavated over most of the 13-acre site to a depth of roughly 10 feet below existing ground level. Excavation will require removal and disposal of roughly 177,000 cubic yards of soil. The wetted area of the basin will be approximately 11 acres. At an average water depth of 10 feet, the basin will retain roughly 110 acre-feet of water. Given similar geology and close proximity, it is estimated that the percolation capability of the proposed Miraloma Basin will be similar to that of Kraemer Basin. The average annual Kraemer Basin recharge rate of 2.7 feet per day can be used to estimate the recharge rate of the Miraloma Basin. Assuming that the Miraloma Basin is 11 acres, the recharge capacity is estimated to be 11 acres times 2.7 feet per day, or 30 acre-feet/day. On an annual basis, this corresponds to approximately 10,000 acre-feet per year.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	Orange	Modjeska Park Parking Detention/Infiltration Facility	$250,000	The project utilizes an existing 37,000-square-foot parking lot (at Modjeska Park) footprint to install an underground detention/infiltration facility. It consists of the removal of the existing paving surface, excavation, and construction of inlet and outlet Reinforced Concrete structures; the installation of detention/infiltration reinforced-concrete box to capture the stormwater flows from the existing 48–inch reinforced-concrete pipe storm drain flowing southerly along Nutwood Avenue. Stormwater captured will percolate through the basin invert and replenish the groundwater table. It also includes back filling, paving of the existing parking lot, striping, and all work shown on the construction documents.	Yes	Water Supply
South Coast	Orange	Orange County Regional Stormwater Infiltration Program	$2,000,000	The Project will create a program to develop new regional infiltration facilities and expand existing facilities to capture stormwater runoff from new development and significant redevelopment at various sites throughout Orange County in cases where on-site capture and infiltration is feasible due to site constraints, such as soil conditions, groundwater levels, and soil or groundwater contamination, or has potential to cause or contribute to degradation of groundwater quality	Yes	Water Quality
South Coast	Orange	Santa Margarita Water District Gobernadora Multipurpose Basin Project	$9,009,085	(1) Urban runoff water quality basin to improve water qualify for downstream riparian and wetlands areas; (2) stormwater detention basin to protect downstream wetlands and riparian habitat from erosion and deposition damage; (3) collection system to capture and harvest drainage flows for recycled water use in the existing Portola Reservoir; and (4) regional trail link for overall trail connection from Thomas F. Riley Park to Caspers Wilderness Regional Park.	Yes	Water Quality
South Coast	Orange	Serrano Creek Restoration Plan	$3,345,212	Serrano Creek, a tributary of San Diego Creek, drains an area of about 2,590 acres in the upper watershed for the Newport Bay. Serrano Creek is in the Newport Bay Watershed. The Newport Bay currently has a sediment TMDL, which is linked in part to the severely eroding banks in Serrano Creek. The banks of Serrano Creek have undergone substantial erosion due to upstream development in recent years. As a result, private property and public trails are at risk, riparian habitat is degraded and open space has been lost. In general, sediment supply to the unimproved stream has been reduced and local runoff has increased both in peak flow and duration. This project will implement bank stabilization and restoration measures for portions of Serrano Creek Reach 2, between Trabuco Road and Portola Parkway, in the City of Lake Forest	Yes	Water Quality
South Coast	Orange	Wood Canyon Emergent Wetland Project	$204,000	Construction of emergent wetland to enhance habitat, support functions/values, improve water quality, and mitigate channel incision, degradation, and flooding.	Yes	Ecosystem
South Coast	Riverside	Bedford Wash and Temescal Wash Flood Protection Corridor Project	$6,435,000	The proposed project, in conjunction with surrounding projects, which includes the Dos Lagos Redevelopment Area, represents a model mixed land use approach designed to reclaim a 600-acre area damaged by more than 70 years of silica mining extraction and processing, and general manufacturing activity. The restoration of Bedford Wash and Temescal Wash in combination with the balanced and sustainable approach to the redevelopment of the larger and surrounding area, make this a unique and important project. The remediation, restoration, and preservation of Bedford and Temescal Washes will integrate with surrounding development and ongoing land use planning efforts such as the preservation of 135 acres of open space, linking the 13,000 acre Lake Matthews-Estelle Reserve with restoration activities to Temescal Wash.	Yes	Ecosystem
South Coast	Riverside	Lake Mathews Watershed Master Water Quality Improvement Project Phase II	$8,000,000	The Drinking Water Quality Management Plan (DWQMP) was completed in the early 1990s through an active partnership between Metropolitan Water District of Southern California, Riverside County FCWCD, and the County of Riverside. The DWQMP investigated the effects that development may have on lake water quality and recommended steps to reduce nonpoint source pollution into Lake Mathews. The Cajalco Creek Dam and Detention Basin were constructed as Phase I of that plan. The Project partners are updating the watershed study based on updated development projections, changing regulatory environment, and state-of-the-art stormwater treatment options. Phase II of the Project will implement the updated recommendations and consist of infiltration basins, extended detention basins, constructed wetlands, and/or other BMPs located strategically along Cajalco Creek and other watershed tributary drainages. The Phase II project components will coordinate with site-specific BMPs to be implemented by new development in the watershed.	Yes	Water Quality
South Coast	Riverside	Master Drainage Plan Enhancement and Implementation in Riverside County	$205,000,000	This project proposes updates to the District's Master Drainage Plans (MDPs) to reflect current environmental constraints. An update will result in plans that make environmental benefits a priority, identify retrofit opportunities, and utilize regional opportunities for environmental mitigation (such as for TMDLs and Municipal Separate Storm Sewer System permit compliance). This project would construct un-built MDP facilities and retrofit existing flood control facilities in the Anza, Murrieta, and Wildomar Master Plans.	Yes	Ecosystem
South Coast	Riverside	Mockingbird Canyon Restoration	$4,250,690	Upon further investigation, the best long-term solution appears to be the restoration and stream bank stabilization of Mockingbird Canyon wash. Rather than collecting the debris from these areas every year, this approach focuses on improving reaches of the wash so that they become stable and vegetated over time, hence, transporting less sediment. A field investigation showed that some reaches of the wash are healthy, with good habitat, and with only a few invasive plants. However, some portions of the wash have no vegetation and erode quite heavily. Typically this erosion occurs downstream of private driveway culverts and road crossings. To address this issue, it would be best to work toward restoring the natural wash, which would involve studying the wash as a whole, acquiring right of way, and stabilizing the wash over time.	Yes	Ecosystem
South Coast	Riverside	Phases 2-4 of the Homeland/Romoland Line A Master Drainage Plan	$16,181,233	Storm drain improvements to (1) provide protection from historic flooding and remove impacted properties from the 100-year floodplain; (2) improve water quality by reducing top soil erosion and pollutants and implementing water quality BMPs; (3) construct drainage basins and remove 500,000 tons of silt and debris that currently flow to the San Jacinto River, thereby assuring higher quality water supply to both Canyon Lake and Lake Elsinore; (4) provide flood control protection for the recently flooded Heritage High School, the fire station, existing Edison substation, businesses and homes (5) recharge the local groundwater basin and create an infiltration area for recharge during low level storm events; (6) create community parks, trails and recreation facilities with drought-resistant landscaping for use by local residents; and (7) facilitate new development and provide permanent jobs in an existing community with high unemployment rates.	Yes	Water Quality
South Coast	Riverside	San Jacinto River Gap Project	$40,000,000	The project consists of a soft-bottom channel with levees from Sanderson Avenue to a point about 10,000 feet west and then northwest about 6,000 feet to Bridge Street. The channel will have capacity for about a 25-year storm event (31,000 cfs). There will be grade control structures in the channel. Enhanced habitat values will be provided along the channel alignment so it can be used as a corridor to connect the San Jacinto Wildlife Area (SJWA) between the Portrero and Davis Units of the SJWA. This project would prevent flows up to the 25-year storm from breaking out across agricultural land and thereby reduce nutrient loading to storm runoff; it would make an important contribution toward the delisting of Canyon Lake and Lake Elsinore as impaired water bodies; it would provide critical habitat corridor linkage for the Portrero and Davis Units of the SJWA (the SJWA is the No. 1 priority habitat area in Riverside County for the Multispecies Habitat Conservation Plan); it would provide managed habitat for the Los Angeles Pocket Mouse and San Bernardino Kangaroo Rat; and it would respect water rights in the region.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	Riverside	Santa Margarita Region Retrofit Opportunities Study and Program Framework	$70,495	Study to identify and prioritize existing areas of development that have the potential to cause water quality impairments as a result of urbanization, as well as the development of a program framework to be used to further refine prioritizations based on water quality data analysis. The study would develop a retrofit program that can be implemented through the Upper Santa Margarita Watershed IRWM Region to holistically address water quality issues associated with urban development. This study would support the project (Water Quality Enhancements in Riverside County) to reduce impacts from hydromodification, promote low-impact development, support riparian and aquatic habitat restoration, reduce the discharges of stormwater pollutants, and improve water quality. A focus for candidates will include areas where receiving waters are channelized, hardened, and/or eroded. Candidates will also include the development tributary to these receiving waters and developed areas generating pollutants to environmentally sensitive areas. The retrofit program framework will become part of ongoing stormwater management programs and will serve as a guidance for City and County agencies to effectively implement retrofit projects. The framework will include a menu of project types and establish incentives and partnership programs. Also included will be a tracking mechanism for completed projects and guidance for ongoing evaluation for additional retrofit program candidates.	Yes	Water Quality
South Coast	Riverside	Temescal Creek Floodplain Acquisition	$10,089,280	Acquisition of floodplain area for flood protection, water conservation, and habitat mitigation banking. Scope of acquisition not fully defined.	Yes	Ecosystem
South Coast	Riverside	Water Quality Enhancements in Riverside County	$36,500,000	The project aims to reduce impacts from hydromodification, promote low-impact development, support riparian and aquatic habitat restoration, reduce the discharges of stormwater pollutants, and improve water quality. The project builds on the Santa Margarita Region Retrofit Opportunities Study and Program Framework, which involves identification of retrofit opportunities in the Santa Margarita Watershed, including researching, inventorying, and prioritizing areas of existing development (i.e., municipal, industrial, commercial, residential) as candidates for targeted retrofit projects that would reduce the impacts of existing development on the watershed. Specific outreach will occur through the education of homeowners associations (HOAs) that will serve to identify the need and benefits to retrofit existing common landscaped areas. The project also involves hydromodification management, which will guide and support the planning, design, and construction of priority new and significant redevelopment projects (PDPs) within the Upper Santa Margarita Watershed to manage increases in runoff discharge rates and durations.	Yes	Ecosystem
South Coast	San Bernardino	14th Street Storm Water Collection/Integration Project - Upland	$5,000,000	The project that will provide flood protection by capturing and conveying storm flows to Upland Basin. The additional benefits such as water quality and groundwater recharge through the construction of a detention/retention basin will allow recharge of storm flows into multiple aquifer basins and the decrease of pollutants and silt transportation into downstream sensitive habitat/species areas such as Santa Ana River and Prado Dam. In addition, the proposed project will be capable of mitigating flood damage and loss of life from a potential catastrophic San Antonio Dam failure.	Yes	Water Supply
South Coast	San Bernardino	Antelope Valley Wash Recharge Ponds	$800,000	Antelope Valley Wash Recharge Ponds could provide groundwater recharge upgradient from City of Hesperia wells. The Hesperia Master Plan of Drainage identifies a 65-acre site for a stormwater detention basin in the Antelope Valley Wash south of Ranchero Road. In addition to stormwater detention, the site might be able to accommodate groundwater recharge. The Morongo Basin Pipeline passes by this area and would be the source of recharge water.	Yes	Water Supply
South Coast	San Bernardino	Cactus Basins Number 3 and 3A	$10,000,000	As part of the proposed I-210 freeway construction project, Caltrans reconstructed Cactus Channel, which intercepts flows to the north of the proposed freeway and discharges into the Cactus Basins, south of the freeway. As a result of the new construction, additional flows will be collected in Cactus Channel and discharged into the Cactus Basins. Cactus Basins, therefore, will need to be enlarged to mitigate the increased flow. The Cactus Basin improvements will consist of three in-series detention basins upstream of Baseline Road. The first phase of construction will consist of improvements to Basins 3 and 3A. Surface water in the area will flow southward from the existing Cactus Channel into Basin No. 3 and from there into Basin No. 3A. Surface water will then flow from Basin No. 3A through an existing reinforced concrete box and pipe structure (located in the southwest corner of Basin No. 3A) under Baseline Road into the existing Rialto Channel and Basins 1 and 2.		
South Coast	San Bernardino	Cactus Basins Number 4 and 5	$21,600,000	As part of the proposed I-210 freeway construction project, Caltrans reconstructed Cactus Channel, which intercepts flows to the north of the proposed freeway and discharges into the Cactus Basins, south of the freeway. As a result of the new construction, additional flows will be collected in Cactus Channel and discharged into the Cactus Basins. Cactus Basins, therefore, will need to be enlarged to mitigate the increased flow. The Cactus Basin improvements will consist of a series of detention basins upstream of Baseline Road.		
South Coast	San Bernardino	Chino Creek Multipurpose Corridor	$13,900,000	Creation of a multipurpose green corridor along Chino Creek, including reconfiguring the channel cross section and creating floodplain terraces that will allow flood flows to dissipate energy and decrease velocities. Grade control structures will stop channel bed erosion. Bioengineering methods will be used to stabilize bank. Will revegetate and create 51 acres of new native vegetation, create 3.2 miles of trails, and 2.1 miles of riparian corridor. Subproject areas include: (1) channel restoration/grade control near Central Avenue Bridge; (2) bank stabilization near Kimball Avenue; (3) storm drainage confluence improvement near Chino Creek Park; (4) floodplain park near Magnolia Channel confluence and Chino Hills soccer complex; (5) stream restoration through El Prado Golf Course.	Yes	Ecosystem
South Coast	San Bernardino	Cushenbury Flood Detention Basin	$2,000,000	The project is proposed to capture runoff from the San Bernardino Mountains in the Lucerne Valley Sub-basin. Currently, large storm flows drain to dry lakebeds in the area that have low percolation rates. Consequently, the majority of water that drains to the lakebeds is lost to evaporation and never enters the basin. The project would divert storm flows to detention basins with high rates of percolation to decrease losses from evaporation.	Yes	Water Supply
South Coast	San Bernardino	Enhanced Stormwater Capture and Recharge along the Santa Ana River Phase I	$8,000,000	The Enhanced Stormwater Capture and Recharge along the Santa Ana River project consists of enhancing the Cuttle weir diversion structure, improvements to the existing San Bernardino Valley Water Conservation District Canal, construction of Valley District's Plunge Pool Pipeline Phase I, construction of pretreatment facilities, improvements to the existing spreading grounds and construction of new spreading grounds. The project will achieve: (1) increased utilization of stormwater as a water supply, (2) increased storage of imported water during wet years for use during droughts, (3) increased water supply reliability, and (4) improved water quality. The design objectives for these facilities are 80,000 acre-feet in a single year at a maximum instantaneous flow rate of 500 cfs.	Yes	Water Supply

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	San Bernardino	Enhanced Stormwater Capture and Recharge along the Santa Ana River Phase II	$22,000,000	This portion of the Enhanced Stormwater Capture along the Santa Ana River project involves the construction of Plunge Pool Pipeline Phase II. This section of pipe would be approximately 2 miles long and 8 feet in diameter. The completion of Phase II would enable Valley District/western to convey up to 500 cfs from the Santa Ana River to the Metropolitan Water District of Southern California inland feeder for delivery to Western Municipal Water District and Riverside. This project will provide an average additional yield of 2,700 acre-feet a year (104,000 acre-feet over 39 years).	Yes	Water Supply
South Coast	San Bernardino	Etiwanda/San Sevaine Basins 1 through 4	$4,000,000	The proposed debris and sedimentation basins will capture runoff from the mountains and foothills north of the City of Rancho Cucamonga, namely from the East Etiwanda Creek and San Sevaine Creek. The proposed study will be performed such that Basins 1 through 4 may be designed and constructed to be permanent flood control facilities and perform in concert with the recently improved Etiwanda Basin 5 to provide 100-year flood protection. Also to be taken into consideration for the calculation of ultimate basin capacities will be burn events. Even though the basin's primary function will be to provide increased flood protection, it also will provide a reliable water supply, preserve and enhance the environment, ensure high-quality water, use rainfall as a resource, and maintain quality of life.	Yes	Water Supply
South Coast	San Bernardino	Inland Empire Utility Agency Basin Recharge Project	$38,000,000	Inland Empire Utilities Agency is lead agency for a proposal to use 19 existing basins within the Chino Basin to recharge stormwater and imported water.	Yes	Water Supply
South Coast	San Bernardino	Lytle Cajon Basin	$1,000,000	The debris and sedimentation basin currently captures runoff from the mountains and foothills north of the City of San Bernardino, namely from Lytle Creek. The purpose of this proposed study is to determine the characteristics and extent of the drainage area as sediments are washed toward the basins downstream gatehouse and to explore methods of operation or construction concepts that would more fully utilize the East Branch Lytle Creek Channel, as by design, it could certainly take more frequent flows and relieve the pressure from Lytle-Cajon Channel. For the past several years, the invert of Lytle-Cajon Channel has received all of the debris from the watershed drainage areas as it travels down this channel to its confluence with Warm Creek. This debris received by the Lytle-Cajon Channel has caused severe erosion and damage to the channel invert, with many areas exposed to the second layer of reinforcement bar. Even though the basins primary function will in fact be to provide increased flood protection, it will also provide a reliable water supply, preserve and enhance the environment, ensure high water quality, use rainfall as a resource, and maintain quality of life.	Yes	Water Supply
South Coast	San Bernardino	Mission Zanja Creek Feasibility Study	$1,000,000	The objective of the study will be to build upon the previous watershed planning efforts and provide viable alternatives, implement water quality, and water supply aspects on a regional scale for the next generation. In addition, the study will provide avenues for responsible preservation and enhancement of the practical and sentimental values of the Zanja to the Native Gauchama Indians and its place in the National Register of Historical Places through potential partnerships in recreational and educational uses. The goals of the study focus on solving the flooding issues, implementing economic and environmentally viable alternatives for the long term vision.	Yes	Water Quality
South Coast	San Bernardino	Turner Basin Improvements	$13,453,000	The project area includes flood control channels, water conservation basins and regional park facilities. The property is located between I-10 Freeway and 4th Street and it is bifurcated by Archibald Avenue. Archibald Avenue, a major collector street, is one of the main transportation corridors into Rancho Cucamonga from I-10 and Ontario and is essentially a "Gateway" into Rancho Cucamonga. In 2003 Inland Empire Utilities Agency with Chino Basin Watermaster constructed water conservation facility improvements including expansion of the stormwater retention basins to capture and conserve additional stormwater including improvements on the western area of the Turner basin site. The Turner Basins Improvements will be a multiple beneficial use project that maximized the use of the Turner basin site by constructing stormwater capture basins, groundwater recharge basins, wetlands, native landscaping, road way improvements, recreation open spaces, educational trails about conservation and local history, and flood control improvements.	Yes	Water Supply
South Coast	San Bernardino	West Fontana Basin	$10,000,000	The proposed project is the basin portion of an overall project that will include the expansion and lining of the existing West Fontana channel and construction of a flow-by basin along the alignment and at an existing quarry pit (near Tokay Avenue). The existing channel is currently 12 feet wide and unlined. The design of the channel improvements, including the flow-by basin has been selected from eight alternatives submitted by the County to the Regional Water Quality Control Board. The alternative selected would convey the 100-year flow of 3,515 cfs safely to Banana Basin and provide the adequate freeboard using the San Bernardino County Flood Control District (FCD) right-of-way. Even though the basins primary function will in fact be to provide increased flood protection, it will also provide a reliable water supply, preserve and enhance the environment, ensure high water quality, use rainfall as a resource, and maintain quality of life.	Yes	Water Supply
South Coast	San Diego	Campo Creek Watershed Groundwater management Plan	$1,000,000	This project would design and install an approved streambed, bank and habitat stabilization and enhancement in a section of the valley and creekbed where extreme erosion has occurred. This would enhance groundwater recharge; greatly reduce downstream erosion and sediment transport, revitalize the local valley, creekbed and habitat.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	San Diego	County of San Diego Chollas Creek Runoff Reduction and Groundwater Recharge Project	$1,600,000	The Chollas Creek Runoff Reduction and Groundwater Recharge Project is a project to reduce runoff from five County of San Diego facilities in the Chollas Creek subwatershed of the Pueblo San Diego hydrological unit. These facilities occupy sites that are highly impervious and could be retrofitted with low-impact development (LID) components to reduce runoff and promote infiltration. Since each of the properties has been developed to facilitate public access, and each site consists, in part, of significantly sized impervious parking lots, one component of this project will be to use what has been learned to date about porous pavements in the Porous Pavement and Model Municipal Operations Demonstration Project as the basis for retrofitting portions of the parking lots with porous pavement over stone reservoirs to capture runoff from the parking lots, and, where feasible, to also capture runoff from roof drains. The second major component of the project includes the application of other stormwater BMPs at the five County facilities that demonstrate vegetated roof systems and capture/reuse technologies, as well as landscape elements such as rain gardens. With an average annual rainfall of only about 10 inches per year, greater attention must be given capturing and reusing as much rainfall as possible. This project will demonstrate techniques to capture rainfall and to infiltrate or return to the atmosphere rainwater that cannot be captured and reused. The purpose of this retrofitting is to prevent runoff from these impervious surfaces from transporting pollutants -- particularly copper, lead, and zinc that have been directly deposited on the properties through atmospheric deposition and through the storm drain system -- to Chollas Creek, which has been listed as impaired by copper, lead, and zinc and is the subject of a total maximum daily load (TMDL) currently proposed for approval by the San Diego Regional Water Quality Control Board.	Yes	Water Supply
South Coast	San Diego	De Luz Road and Channel Repairs	$975,000	The proposed project entails roadway and embankment repair, fence replacement, traffic striping, and restoration of two spillways. A temporary asphalt concrete patch will be removed and replaced with an asphalt concrete pavement section covering approximately 1,500 square feet of existing roadbed near the Santa Margarita River Bridge for De Luz Road. Damaged asphalt concrete dikes will be removed and replaced over a distance of approximately 450 feet. The road fill prism on the south bridge approach will be armored with installation of a riprap slope on the upstream and downstream faces. To protect the road from future runoff damage, this riprap slope will extend 12 feet underground or to the bedrock in the area, whichever is reached first.	Yes	Transportation
South Coast	San Diego	Foothill/Bobier upsize - Vista	$2,127,587	This project has been separated from the annual Street Rehabilitation and Maintenance (CIP #8037) due to the scope of the work. The project will reconstruct the portion of Foothill Drive between Beverly Drive and Vale Terrace. Four segments, which include Beverly Drive to Warmlands Avenue (3), Warmlands Avenue to north of Troy Place (4), north of Troy Place to south of Vine Circle (5), and south of Vine Circle to Vale Terrace (6), will be reconstructed to 24 feet wide with an asphalt concrete dike on each side to control drainage. Segment No. 5 (north of Troy Place to south of Vine Circle) will be reconstructed as a semi-rural arterial and will be 28 feet wide with a concrete curb and gutter. A graded disintegrated granite walkway for pedestrians will be installed on the east side of Foothill Drive between Vale Terrace Drive and north of Troy Place to serve the new Rancho Minerva Middle School.	Yes	Transportation
South Coast	San Diego	Forester Creek Improvement Project		This funding is being requested to widen the Forester Creek channel and to restore ecosystem function to the last viable stretch of Forester Creek before it enters the San Diego River. In its current condition the creek in Santee has a channel width of 75 to 100 feet and can carry only a 10-year flow between its banks. The newly widened channel is designed to achieve 100-year flood capacity and will have a top width varying from 181 feet to 358 feet. Exotic plant species will be removed from the project area. Approximately 17 acres of native riparian vegetation will be created through a planting and plant establishment program.	Yes	Ecosystem
South Coast	San Diego	Implementing Improvements to the Rose Creek Watershed: Controlling Invasive Exotic Species	$742,500	This IRWMP proposal will support the removal and subsequent restoration of approximately 68 acres of invasive exotic plants in the Rose Creek Watershed in a manner to maximize improvements in water quality, biological diversity, enhanced public safety, reduced fire risk and enhanced community connections. The final acres of removal/restoration area will depend on the amount of funds awarded as removal costs vary depending on the species and difficulty of terrain which varies throughout the watershed.	Yes	Ecosystem
South Coast	San Diego	La Jolla Shores Ocean Protection Project	$2,192,000	(1) Irrigation Runoff Reduction - Irrigation runoff from the western portion of the University of California, San Diego (UCSD) and Scripps Institution of Oceanography (SIO) campus drains directly into Area of Special Biological Significance (ASBS) No. 31. Portions of the irrigation water distribution system will be improved to reduce water use and prevent irrigation water from discharging into the stormwater conveyance system. Improvements will include installing system controllers to automatically adjust irrigation times in response to changing daily evapotranspiration values and optimize the watering of poor drainage sites, slopes, and heavy soil areas. (2) Pollutant Source Reduction - UCSD and the Urban Corps of San Diego (Urban Corps) will partner to implement BMPs throughout the La Jolla Shores watershed to reduce or eliminate the discharge of pollutants into the ocean including non-stormwater discharges. (3) Kellogg Park Green Lot LID - This low-impact development component will remove the western half of the asphalt paving of the Kellogg Park parking lot in the Peñasquitos Hydrologic Unit and replace it with porous concrete. The porous paving will allow urban runoff to infiltrate into the ground instead of discharging directly to the storm drain system and adjacent La Jolla Shores beach and ASBS. Educational outreach to the surrounding community will also be conducted regarding the benefits of the project in preserving and improving the quality of urban runoff and ultimately the nearby La Jolla Shores Beach.	Yes	Water Quality
South Coast	San Diego	Loma Alta Lagoon Acquisition and Restoration		A restoration plan will be developed to provide guidance and designs for restoration of the five parcels. By enlarging the lagoon in the area of these five parcels, a bottleneck would be removed allowing water to fan out and reduce flooding upstream from the lagoon. Implementation of the restoration plan will include acquiring all necessary permits and installation of native plants. Public access to the restored area would be allowed, but in a confined area of the project. A kiosk and parking area would be designed into the plan, allowing access to residents and visitors. This would provide an opportunity for students to tour the site and possibly be involved in the actual project restoration.	Yes	Ecosystem
South Coast	San Diego	Olive/Maryland Upsize - Vista	$935,912	This project provides for design and construction to widen pavement, install sidewalks and storm drain improvements, acquire right-of-way, Class III bike lane, and parking. This project includes sidewalks on the east side of the street. Tasks to complete the project include: detailed design and construct the project. Phase I was completed in September 2006, which constructed improvements from Olive Avenue to Rose Drive. Phase II will construct improvements from Rose Drive to Highland Drive including Maryland Court, Rose Court, and a portion of Olive Avenue.	Yes	Transportation
South Coast	San Diego	San Marcos Creek Floodway Improvement Project	$12,158,258	The objective of this project is to contain the 100-year storm flows within the channelized area of San Marcos Creek so that disadvantaged areas adjacent to the creek are removed from the floodplain. The project would restore native riparian vegetation within the regraded channel to increase nutrient uptake and reduce sediment flowing downstream into Lake San Marcos.	Yes	Ecosystem

Table H-C-1. Local Planned IWM Projects in California

Hydrologic Region	County	Project Name	Estimated Cost	Project Description	IWM Project	Type of IWM Project
South Coast	San Diego	Santa Maria Creek Flood Protection Corridor	$65,000,000	A significant, far-reaching plan to preserve and protect from development a number of 1,000-acre plus ranches around the town site. There is pressure to develop in this rare coastal upland grassland, much of which constitutes a riparian/seasonal wetland area. This project promises to set aside a large area, and then rebuild the creek and the native habitat to slow the waters, slow the erosion, and restore the riparian zones on Santa Maria Creek.	Yes	Ecosystem
South Coast	San Diego	Stabilization and Restoration of Bonita Canyon Creek - a Tributary of the Sweetwater River		The project will accomplish slope stabilization, channel restoration, and revegetation of degraded earthen channel with native riparian species.	Yes	Ecosystem
South Coast	San Diego	Stabilization and Restoration of Long Canyon Creek - a Tributary of the Sweetwater River		The project will accomplish stabilization of eroded slopes, channel restoration, and revegetation of the degraded earthen channel with native riparian species.	Yes	Ecosystem
South Coast	San Diego	Tijuana River Valley Invasive Plant Control Program - Phase 4	$2,978,000	The proposed project will control exotic plants (particularly giant reed (*Arundo donax*), tamarisk (*Tamarix* spp.) and castor bean (*Ricinus communis*) on 1,100 acres of prime estuarine and riparian habitats in the Tijuana River Valley.	Yes	Ecosystem
South Coast	Ventura	Lower Ventura River Habitat Restoration and Enhancement	$5,000,000	The Lower Ventura River Habitat Restoration project involves acquiring land and conservation easements in the 100-year floodplain along lower reaches of the river. This project will also include habitat restoration and enhancement along the lower 5 miles of the Ventura River up to and including the estuary.	Yes	Ecosystem
South Coast	Ventura	Lower Calleguas Creek - Integrated Watershed Protection - Projects	$345,000,000	Provide a sound framework and guidelines for flood control, life/property protection, sediment management, and a holistic approach in integrated watershed planning and environmental resources management within the watershed. The multiple purpose study encompassed issues related to habitat preservation, land development, erosion/sedimentation, BMPs, flood control, groundwater protection and recharge enhancement, water supply, water quality, and potential sources of funding for recommended projects, among others.	Yes	Ecosystem
South Coast	Ventura	Natural Floodplain Protection Program/Santa Clara Floodplain Conservation Project	$5,000,000	Implementation of the Natural Floodplain Protection Program will preserve a critical section of the remaining undeveloped 500-year floodplain in the Santa Clara River Watershed by acquiring property easements to preclude development. Acquisition of these easements will provide downstream flood benefits by allowing flooding to occur upstream in the watershed.	Yes	Ecosystem
South Coast	Ventura	Ojai Meadows preserve Habitat Restoration and Flood Control Plan	$500,000	At its Ojai Meadows Preserve, the Ojai Valley Land Conservancy seeks $500,000 to complete the final phase of an ecological restoration project to relieve flooding on the adjacent highway and high school, to filter runoff and recharge groundwater, and to restore wetland, riparian, and upland habitat for returning wildlife and the use and enjoyment of visitors.	Yes	Water Supply
South Coast	Ventura	Rice Creek Realignment and Enhancement	$500,000	This project on the Ventura River Preserve of the Ojai Valley Land Conservancy would return Rice Creek to its approximate historical location from its current channelized location. The project will add more than 1,500 feet of new riparian habitat on the site and reestablish floodplain connections and buffer habitats. This project will help shade the water to keep it cool and reduce algal blooms, reduce sedimentation in Rice Creek and the Ventura River via erosion control, increase the numbers and variety of wildlife, and act as infiltration areas to support water storage for the Ventura River.	Yes	Ecosystem
South Coast	Ventura	Virginia Colony Flood Storage and Habitat Enhancement Project	$6,015,015	Project would acquire easements on seven properties, to construct a detention basin on the north side of the railroad tracks, to do mitigation planning, and to cover part of the mitigation costs. Future phases include a detention basin on the south side of the railroad tracks, channel widening, and overflow channel. These facilities would be located on, adjacent to, or downstream from the parcels that could be acquired. Water quality would be improved by trapping sediments. Water storage will add to recharge of the groundwater aquifer. The project will provide passive public recreation.	Yes	Water Quality

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Appendix D: USACE Planned/Proposed IWM Projects in California

APPENDIX D: USACE PLANNED/PROPOSED IWM PROJECTS IN CALIFORNIA

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Table H-D-1. USACE Planned/Proposed IWM Projects in California

Hydrologic Region	USACE District	Counties	USACE Project Name	USACE Project Cost Share (Federal Cost Share)	Project Description	IWM Project	Type of IWM	Project Funded in FY 2012	Funding Appropriated in FY 2012 ($ millions)
San Francisco Bay	San Francisco	Alameda	Estudillo Canal, California	$38,000,000	The study area is located within the city of San Leandro, California, about 15 miles southeast of San Francisco. The watershed drains into San Francisco Bay, with a drainage area of approximately 10 square miles. A substantial number of properties within this densely populated area are designated as being in a Federal Emergency Management Agency (FEMA) Floodplain. The study will evaluate potential flood damage reduction alternatives in a highly developed area.	Yes	Ecosystem, Recreation, Flood Risk Management	No	
San Francisco Bay	Sacramento	Contra Costa	Grayson and Murderer's Creeks, Walnut Creek Basin, California	$2,452,000	The Grayson and Murderer's creeks feasibility study is investigating flood damage reduction, ecosystem restoration and recreation in the Grayson Creek sub-watershed of the Walnut Creek watershed. The study is considering detention basins, channel modifications, levee and floodwall improvements, and other structural and nonstructural measures for flood damage reduction on Grayson Creek and its tributaries. The ecosystem restoration and recreation measures that are being considered would be secondary to the flood damage reduction objective.	Yes	Ecosystem, Recreation, Flood Risk Management	No	
San Francisco Bay	Sacramento	Contra Costa	Lower Walnut Creek General Reevaluation	$3,360,000	The lower Walnut Creek General Reevaluation is a multi-objective project to create a more sustainable facility that maintains or improves the level of flood protection while preserving sensitive habitat for rare and endangered species.	Yes	Flood Risk Management, Ecosystem Restoration	No	
San Francisco Bay	Sacramento	Sacramento, Yolo, Solano, Contra Costa, San Joaquin	Sac-San Joaquin Delta Islands and Levees, California	$6,000,000	Develop a road map to identify water and related land resources problems and opportunities; utilize a watershed approach for the majority of the study area (740,000 acres), possibly incorporating a feasibility level of study for the sponsor's greatest area of concern.	Yes	Ecosystem Restoration, Flood Risk Management	Yes	$971,000
San Francisco Bay	San Francisco	Contra Costa	Wildcat and San Pablo Creeks, California	$5,000,000	The study area is located in the cities of Richmond and San Pablo, California. Reach 1 of the authorized flood risk management project was completed by USACE in 1995, and is located in the city of Richmond. Reach 2, within the city of San Pablo, was not constructed at the time because of concerns about economic justification, and it was subsequently placed in the deferred status. Recent flow/frequency projections, and new FEMA floodplains, as well as a 905b reconnaissance report show that Reach 2 may be economically justified at this time.	Yes	Ecosystem, Water Quality	No	
North Coast	San Francisco	Del Norte	Crescent City Harbor		Ongoing repair and dredging of Crescent City Harbor facilities.	Yes	Recreation	No	
Sacramento River	Sacramento	Glenn	Sacramento River, Glenn-Colusa Irrigation District, California	$23,380,000	Stabilizing the river level on the Sacramento River near Hamilton City is an essential component of the Glenn-Colusa Irrigation District Fish Screen Improvement Project. Stabilization will preserve the agricultural irrigation supplies to roughly 1,200 farm families, while complying with the Federal Endangered Species Act and contributing to the restoration of anadromous fish species in the Sacramento River. Improvement will ensure the continued operation of the pumping facility.	Yes	Agriculture, Water Quality, Water Supply	No	
South Coast	Los Angeles	Los Angeles	Los Angeles County Drainage Area Whittier Narrows Water Conservation, California	$1,200,000	Whittier Narrows Water Conservation project will expand water conservation pool behind Whittier Narrows Dam from 2,500 acre-feet to 3,500 acre-feet. Projected partners are Los Angeles County Department of Public Works, Water Replenishment District of Southern California, and USACE. The $1.2 million USACE cost share total figure reflects Federal appropriations to date (over several years, the last one being in 2010).	Yes	Water Supply	No	ZERO in construction, but LACDA did receive funding as an overall line item of $4,933,170 in O&M
North Coast	San Francisco	Mendocino	Coyote Valley Dam, California	$150,000,000	The study area is located in northern California on the east fork of the Russian River at Coyote Valley, near the city of Ukiah. The Russian River drains an area of 1,485 square miles. Approximately two-thirds of this area is in Sonoma County, with the remainder in Mendocino County. The existing USACE project, Coyote Valley Dam, which was completed in 1957, consists of an earth-filled dam 160 feet high and 3,560 feet long, with a reservoir storage capacity of 122,000 acre-feet. The authorized project included sediment, flood risk management, and domestic and agricultural water supply pools with a total storage capacity of 199,000 acre-feet. An additional water supply portion, which included additional storage for about 77,000 acre feet, was placed in the deferred category as local interest considered it unnecessary at that time. Since then, increased development has	Yes	Agriculture, Water Quality, Water Supply	No	

Table H-D-1. USACE Planned/Proposed IWM Projects in California

Hydrologic Region	USACE District	Counties	USACE Project Name	USACE Project Cost Share (Federal Cost Share)	Project Description	IWM Project	Type of IWM	Project Funded in FY 2012	Funding Appropriated in FY 2012 ($ millions)
					created a need for additional water supplies.				
San Francisco Bay	Sacramento	Napa	Napa River, California	$283,093,000	The Napa River Flood Protection Project will provide 100-year flood protection to the City of Napa, protecting business and residences, and improving water quality, creating urban wetlands, enhancing wildlife habitats, and creating over 730 acres of tidal wetlands.	Yes	Flood Risk Management, Recreation	Yes	$1,300,000
San Francisco Bay	San Francisco	Napa	St. Helena Comprehensive Flood Protection Project, California	$30,000,000	The project is located within the city of St. Helena along the Napa River. Major floods have occurred on the Napa River in this area in 1986, 1995, 1997, and 2006. Combined, these floods cost the community over $95.6 million in property damages. The project will restore habitat of the natural floodplain terraces, including riparian and aquatic habitat. Also, the project will restore native plant and tree communities through revegetation efforts and is needed to provide 100-year flood protection to the area. The Water Resources Development Act (WRDA) of 20 07 authorized the construction of the project substantially in accordance with the California State Environmental Impact Report, as opposed to a Chief's Report.	Yes	Ecosystem, Water Quality	No	
South Coast	Los Angeles	Orange	San Juan Creek, South Orange County, California	$3,265,000	The feasibility study will investigate flood risk management alternatives and other related purposes along the lower portions of San Juan, Trabuco, and Oso creeks.	Yes	Ecosystem	No	
South Coast	Los Angeles	Orange	Santa Ana River Basin, California	$2,102,400,000	The Santa Ana River Mainstem Project is designed to provide flood protection to the growing urban communities in Orange, Riverside, and San Bernardino counties. The proposed improvements to the system cover 75 miles, from the headwater of Santa Ana River east of the city of San Bernardino to the mouth of the river at the Pacific Ocean, between the cities of Newport Beach and Huntington Beach.	Yes	Ecosystem, Recreation, Water Quality	Yes	$3,425,400 in O&M; the MAINSTEM project received $23,093,000 in Construction
South Coast	Los Angeles	Orange	Surfside - Sunset - Newport Beach, California	$75,100,000	This project supports periodic beach nourishment in Surfside, Sunset, and Newport Beach.	Yes	Recreation	No	
South Coast	Los Angeles	Orange	Westminster (East Garden Grove) Watershed, California	$6,260,000	A comprehensive study of the Westminster Watershed, including the East Garden Grove-Wintersburg Channel and the Bolsa Chica Flood Control Channel to develop a rehabilitation plan that will consider flood risk management, ecosystem restoration, recreation, and water quality solutions. This project is consistent with the USACE flood risk management and environmental restoration missions in Southern California.	Yes	Ecosystem, Recreation, Water Quality	No	
South Coast	Los Angeles	Orange, San Diego	California Coastal Sediment Master Plan, California	$7,100,000	This project will develop a comprehensive master plan for the conservation, restoration, and preservation of the valuable sediment resources along the coast of California to reduce shoreline erosion and coastal storm damages, provide for environmental restoration and protection, increase natural sediment supply to the coast, restore and preserve beaches, improve water quality along coastal beaches, and optimize the beneficial use of material dredged from ports, harbors, and other opportunistic sediment sources.	Yes	Ecosystem, Water Quality	Yes	$861,000

Table H-D-1. USACE Planned/Proposed IWM Projects in California

Hydrologic Region	USACE District	Counties	USACE Project Name	USACE Project Cost Share (Federal Cost Share)	Project Description	IWM Project	Type of IWM	Project Funded in FY 2012	Funding Appropriated in FY 2012 ($ millions)
South Coast	Los Angeles	Riverside	Murrieta Creek, California	$122,200,000	The project is a multi-purpose flood risk management, environmental restoration and recreation project along 7.5 miles of Murrieta Creek. The major project features include: • Channel widening and deepening • Environmental corridor along the length of the project • Multipurpose detention basin • Wetland restoration area • Recreation park • Three bridge replacements	Yes	Ecosystem, Recreation, Water Quality	No	
South Coast	Los Angeles	Riverside	Prado Basin Water Supply, California	$1,465,000	Feasibility Report for the Proposed Prado Basin Water Supply. The project will result in increasing the water storage pool during the flood season from an elevation of 494 feet to an elevation of 498 feet within Prado Basin. This will enable increased water recharge at the Orange County Water District's recharge facilities downstream of Prado Dam.	Yes	Water Quality, Water Supply	No	
Sacramento River	Sacramento	Sacramento, Yolo, Solano, Contra Costa, San Joaquin	CALFED Levee Stability Program, California	$196,000,000	A report that identified and prioritized potential levee stability projects in the Delta. Through the CALFED Levee Stability Program, the USACE is authorized to participate in flood risk improvements to Delta and Suisun Marsh levees with the potential for incorporation of ecosystem restoration elements. Additionally, the authorization has provided the opportunity to develop Emergency Response Planning tools in partnership with the California DWR.	Yes	Ecosystem Restoration, Flood Risk Management	No	
South Coast	Los Angeles	San Diego	Imperial Beach, Silver Strand Shoreline, California	$84,410,000	The Imperial Beach shoreline has been heavily impacted by erosion, which is caused by a lack of sediment transfer from the Tijuana River and San Diego Harbor due to dam and jetty impediments. The sources of this erosion are a Federal jetty protecting the San Diego Harbor and three dams on the Tijuana River, two of which are Federal. Funding would provide the Federal portion for the placement of beach sand to protect private and public property and preserve recreational opportunities.	Yes	Recreation, Water Quality	No	
South Coast	Los Angeles	San Diego	San Luis Rey River, California	$76,900,000	The Project includes the following:• Double levee, 5.4 miles long• Stone protected channel with a soft bottom• 1,330 feet of parapet walls at the ocean on the north and south levees• Six interior drainage ponds• 5-mile bike trail• 247 acres of conservation lands	Yes	Recreation, Water Quality	Yes	$1,300,000
South Coast	Los Angeles	San Diego	Solana Beach, California	$10,096,000	A study of shoreline erosion along 8 miles of San Diego County coastline. Bluff erosion is extremely dangerous to the public, considering that portions of the bluffs have collapsed and threaten private property.	Yes	Recreation	Yes	$300,000
San Francisco Bay	San Francisco	San Mateo, Santa Clara	San Francisquito Creek, California	$53,000,000	The study area is located in the northern portion of Santa Clara County, and in southern San Mateo County, in northern California, about 22 miles south of San Francisco. San Francisquito Creek has an inadequate carrying capacity due to vegetation, sedimentation, land subsidence, levee settlement, and erosion. Flooding from the creek affects the cities of Menlo Park and East Palo Alto in San Mateo County, and Palo Alto in Santa Clara County. San Francisquito Creek starts at the base of Searsville Dam at Stanford University and flows into the San Francisco Bay about 2.5 miles south of the Dumbarton Bridge. As a result of record rainfall in February 1998, San Francisquito Creek overtopped its banks, affecting approximately 1,700 residential and commercial structures and causing more than $26.6 million in property damages. The study will evaluate potential improvement plans to help alleviate flooding problems, as well as address environmental degradation of the watershed.	Yes	Ecosystem	No	
Central Coast	Los Angeles	Santa Barbara	Lower Mission Creek Flood Control and Restoration Project	$90,229,000	The purpose of this project is to improve the flood flow conveyance and habitat for aquatic species of Mission Creek through the downtown area of the City of Santa Barbara.	Yes	Ecosystem	No	

Table H-D-1. USACE Planned/Proposed IWM Projects in California

Hydrologic Region	USACE District	Counties	USACE Project Name	USACE Project Cost Share (Federal Cost Share)	Project Description	IWM Project	Type of IWM	Project Funded in FY 2012	Funding Appropriated in FY 2012 ($ millions)
San Francisco Bay	San Francisco (Design and Construct), Sacramento (Investigation)	Santa Clara	Coyote and Berryessa Creeks, California	$18,000,000	The purpose of this project is to provide flood protection for Silicon Valley's high-tech, commercial industries, and residential areas with potential damages from a 1 percent flood exceeding $202 million. Alternatives will be selected in an environmentally sensitive way that is acceptable to the local community and that addresses sedimentation and water quality issues.	Yes	Flood Risk Management, Water Quality	Yes	$276,000
San Francisco Bay	San Francisco	Santa Clara	South San Francisco Shoreline, California	$500,000,000	The study area is located along the shoreline of South San Francisco Bay, California, extending from the city of Palo Alto to city of San Leandro. A substantial portion of the Bay shoreline consists of levees that provide protection from tidal flooding for an extensive residential, commercial, and industrial area. These levees are part of an extensive system of former salt manufacturing ponds, which can be restored to vital wetland habitat that would support multiple threatened and endangered species. The last estimated value of the urban development in low-lying areas along the Bay shoreline is approximately $5.5 billion (at September 1998 price levels). The study will reexamine tidal and fluvial flooding problems, and restoration opportunities, and potential alternative solutions.	Yes	Ecosystem, Recreation, Water Quality	Yes	$353,000
Central Coast	San Francisco	Santa Cruz	Pajaro River at Watsonville, California	$220,000,000	This originally authorized flood control project will address flooding from the existing Pajaro River and Salsipuedes Creek project (1949) and from Corralitos Creek. The study objective is to develop a plan that provides a 100-year level of protection on both the mainstem and tributaries. This project is limited to benefits based on the Net Economic Development, although environmental sustainability will be considered because the Pajaro River contains endangered fish species.	Yes	Ecosystem	No	
Tulare Lake	Sacramento	Tulare	San Joaquin River Basin, Frazier Creek, California	$1,500,000	The purpose of this study is to determine Federal interest in providing flood risk management, environmental restoration, recreation, and water quality improvements on Frazier and Strathmore creeks.	Yes	Ecosystem, Water Quality, Flood Risk Management, Recreation	No	
Tulare Lake	Sacramento	Tulare	Success Dam, Tule River, California (Dam Safety)	$500,000,000	Success Dam is an earthen flood risk management dam on the Tule River in the southern San Joaquin Valley. USACE has downgraded its risk potential associated with dam and remediation alternatives to be determined.	Yes	Dam Safety, Irrigation, Water Supply	Yes	$12,600,000
Tulare Lake	Sacramento	Tulare	Tule River, California	$18,200,000	Success Dam is an earthen flood risk management dam on the Tule River in the southern San Joaquin Valley. USACE has downgraded its risk potential associated with dam and remediation alternatives to be determined.	Yes	Water Supply, Irrigation	No	
Tulare Lake	Sacramento	Tulare	San Joaquin River Basin, White River and Deer Creek, California	$1,500,000	The purpose of this study is to determine Federal interest in providing flood risk management and environmental restoration on White River, Dear Creek, and adjacent streams in the vicinity of the town Earlimart California.	Yes	Ecosystem, Flood Risk Management	No	
South Coast	Los Angeles	Santa Barbara	Matilija Dam Ecosystem Restoration	$140,000,000	The purpose of this project is to remove Matilija Dam and to identify mitigation.	Yes	Ecosystem	No	
South Coast	Los Angeles	Santa Barbara	Ventura and Santa Barbara County Shoreline, California	$2,930,000	The purpose of the project is to identify and quantify the pathways for near-shore sediment transport in Santa Barbara and Ventura counties, with emphasis on critical regions of shoreline erosion.	Yes	Ecosystem	No	

Appendix E: Detailed IWM Case Studies

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Appendix E: Detailed Descriptions of Case Studies

Detailed case studies from across the state were developed. The following case studies demonstrate how an IWM approach is used to address various flood hazard types and provide multiple benefits. Each case study provides a summary of regional and agency information, project need, solution describing the IWM approach components of the project, financial information, and project status. The information presented in these case studies is based upon existing and readily available information, as well as additional information collected from project agency partners.

The case studies include:

- Salt River Ecosystem Restoration Project
- Middle Creek Flood Damage Reduction and Ecosystem Restoration Project
- Red Clover Creek Restoration Project
- South San Francisco Bay Shoreline Study
- Lower Carmel River Floodplain Protection and Enhancement Project
- San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4 and 5
- Sun Valley Watershed Management Plan
- Flood Management, Habitat Restoration, and Recharge on the San Diego River

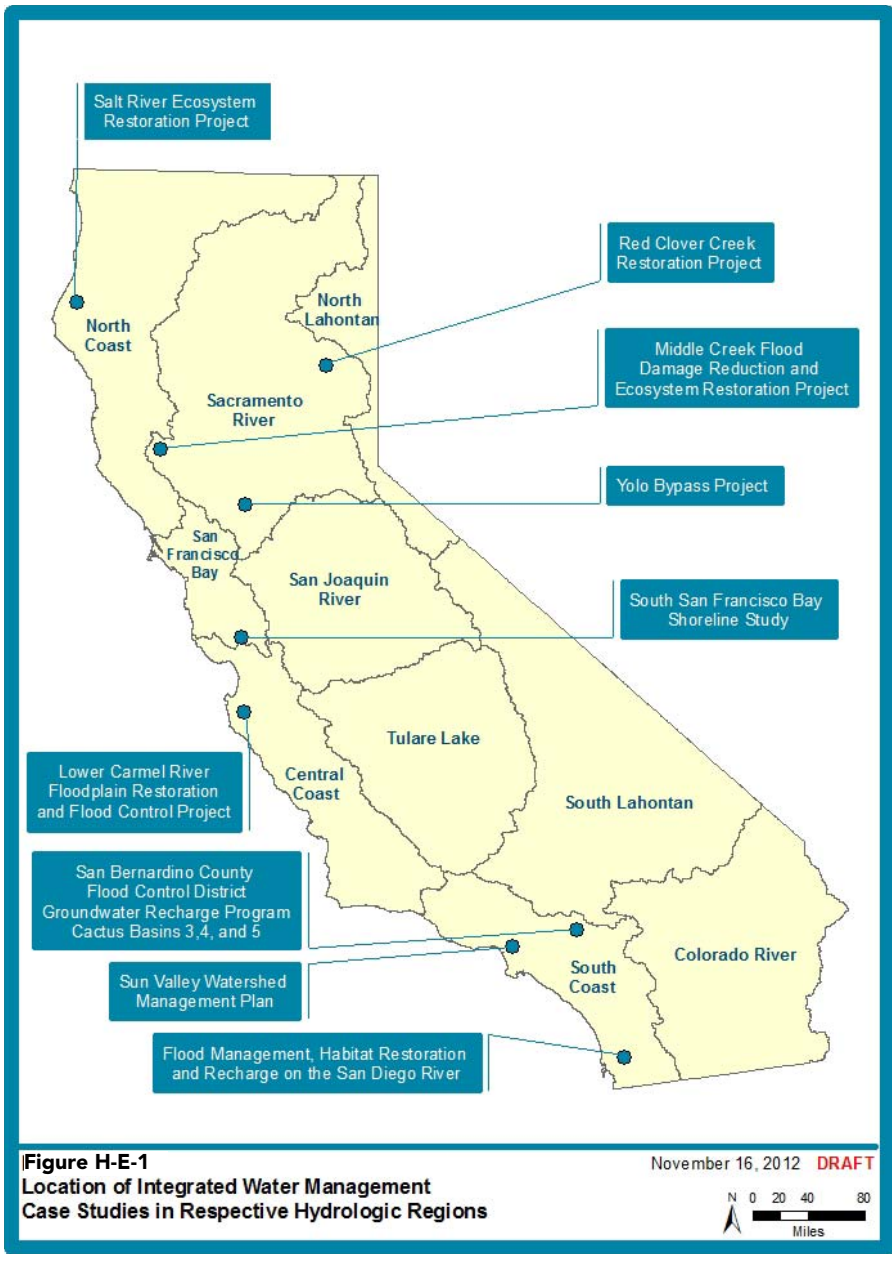

Figure H-E-1
Location of Integrated Water Management Case Studies in Respective Hydrologic Regions

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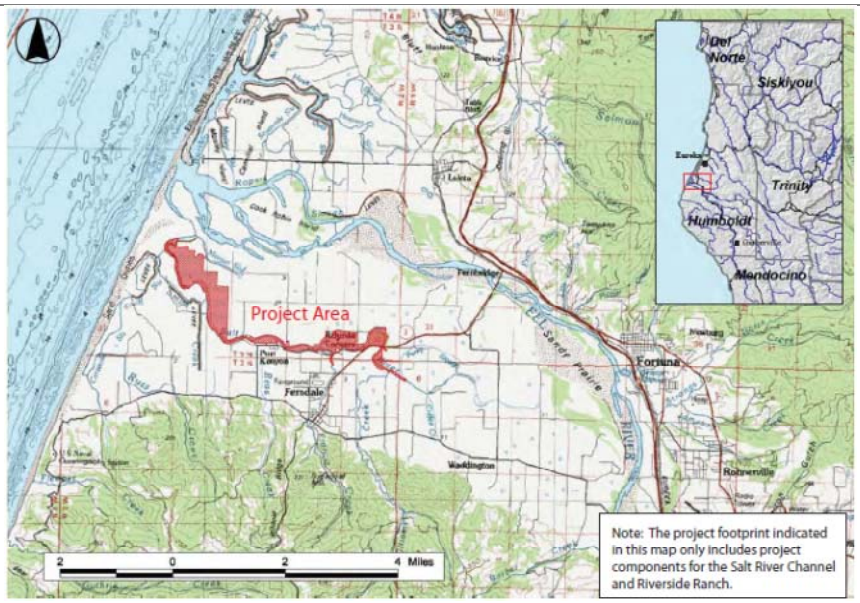
Project Name: Salt River Ecosystem Restoration Project

Responsible Agency	Humboldt County Resource Conservation District (HCRCD)
Partners	The Salt River Ecosystem Restoration Project is being developed through collaboration between private landowners and multiple public agencies, including: • HCRCD • County of Humboldt • City of Ferndale • California Department of Fish and Wildlife (CDFW) • USACE • National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service • U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) • Salt River Advisory Group (SRAG) • Salt River Watershed Council • U.S. Fish and Wildlife Service • State Coastal Conservancy • State Water Resources Control Board • California Wildlife Conservation Board • Caltrans Project partners also include the Wildlands Conservancy, the Western Rivers Conservancy, and Ducks Unlimited. HCRCD has had a long-standing relationship with USACE as partners on the Salt River Restoration Project Continuing Authority Program, Section 206. The USACE has dedicated significant resources and oversight for specific studies, design, and technical assistance. Currently, Ducks Unlimited is negotiating a contract with the USACE for Estuary Restoration Act funds that were recently awarded to the project.
Region/County	North Coast/Humboldt County

Project Area

The Salt River Ecosystem Restoration Project Area lies within the floodplain of the Eel River Estuary. The estuary is located along the northern California coast, approximately 13 miles south of the City of Eureka, California. The estuary is recognized as one of the most ecologically important tidal marsh habitats in California. The Salt River estuary is part of the Humboldt Bay/Eel River estuary complex which encompasses the second and fourth largest estuaries on the California coast. Together, this estuary complex is the only substantial tidal marsh habitat between San Francisco and Coos Bay, Oregon. The project area includes three valuable habitat linkages or corridors—(1) designated critical habitat for salmon and steelhead under the Endangered Species Act, (2) estuarine wetlands critical to one of the most significant shorebird wintering and migration staging areas along the Pacific Flyway, and (3) riparian forest and scrub corridor providing habitat for riparian birds linked to riparian habitat. Currently, most of the lands on or near the project area are in agricultural (mostly dairy) uses. The Salt River watershed ranges in elevation from sea level at the river mouth to approximately 700 feet in upland areas. The steep slopes in the upland tributary areas are sharply contrasted with their flat alluvial valley floors.



Source: Final EIR: Salt River Ecosystem Restoration Project, February 2011, HCRCD

Problems and Need

Sedimentation and loss of natural hydraulic function: Historically, the Salt River was largely influenced by the tide up to 5 miles of its nearly 14-mile length. The tidal exchange of salt water upriver was crucial for maintaining the Salt River channel by flushing sediment from the river and limiting the growth of sediment-trapping aquatic vegetation. Over the years the watershed ecosystem and hydrology were significantly impacted by changes in land use, which accelerated in the late nineteenth century. Now, only a small fraction of the original Salt River Estuary complex is subject to tidal influence due to land reclamation activities, levee and tide gate construction, and channel aggradation. The main channel of the Salt River and the lower reaches of its tributaries have become choked with sediment and willows, and the reaches have lost nearly all natural hydraulic function. Wherever flow is concentrated in remnant riparian areas, the water flows into thick vegetation, slows, and then deposits additional large quantities of sediment throughout the reach, further filling any remaining channel. One foot of sediment deposition per year in any given reach of the project area is commonplace.

Flooding: During the wet season, even small rain events cause the Salt River and the lower reaches of its tributaries to overflow their banks, resulting in almost perpetual flood conditions. The overflow spreads out across the relatively flat landscape, flooding agricultural and residential properties, and threatening public infrastructure. Hundreds of acres of dairy and grazing land are taken out of production for almost 8 months each year due to chronic flooding. Production losses and additional expenses for supplemental feed, pumping out floodwater, and farming and reseeding flooded areas are borne by agricultural producers.

Water quality and drainage: In addition to flooding, the hydraulic dysfunction of the Salt River causes significant problems related to discharge of wastewater treatment plant effluent and overall water quality. Historically, water flows within the Salt River were sufficient to provide the required dilution for discharge from the City of Ferndale wastewater treatment plant. However, sedimentation has reduced channel capacity and the receiving water flows to the point that the effluent violates water quality standards, for which the North Coast Regional Water Quality Control Board has issued a Cease and Desist Order. Treated effluent often flows undiluted into residential areas and agricultural lands, and sediment deposition puts the entire wastewater treatment plant at increasing risk of being flooded. Impaired channel conditions contribute to other water quality problems by limiting drainage of adjacent agricultural lands. These problems increase each winter as the sediment continues to fill drainages.

Loss of habitat: The absence of a clearly defined channel also results in the absence of either freshwater or estuarine aquatic habitat. The Salt River historically functioned as a migration corridor for adult salmonids reaching spawning habitat in tributaries within the Wildcat Mountains, and it provided rearing habitat for juveniles migrating downstream to the Eel River Estuary. However, the current poor fish passage conditions have resulted in drastic population declines of all species of salmonids that formerly used the Salt River and its tributaries. In addition, there has been a substantial loss of wetlands and habitat diversity.

Flood Hazard Type

Types: Debris Flow, Coastal Flooding, Slow Rise, Tsunami Flooding

Flood hazards along the Salt River are related to both overbank flows from the Eel River and storm runoff from its tributaries. This overbank flooding has an estimated recurrence interval of 12 years. Annual flooding of lowland areas is now commonly triggered by relatively minor precipitation events, and areas along the Salt River that formerly drained relatively quickly now remain ponded well into the summer. Tectonic subsidence and sea level rise both work to counteract the impacts of sediment accumulation in the Salt River, but at a much slower or less frequent rate than overbank flooding and associated sediment deposition. Portions of the project area lie inside the county's tsunami wave run-up boundary and are subject to moderate tsunami hazards.

Salt River Flooding near Ferndale
Source: Salt River, Humboldt County, California. Field trips by Ellin Beltz (ebeltz.net), photographs courtesy of Ken Mierzwa, copyright 2004 and all rights reserved.

Solution

The Salt River Ecosystem Restoration Project was developed to respond to the problems described above. It is a multi-year, multi-agency, large public-private partnership endeavor that takes a holistic, watershed-wide approach to address sediment, fish passage, flooding, and drainage issues in the Salt River watershed of Ferndale. The restoration will alleviate the chronic and economically damaging flooding while restoring and enhancing fish and wildlife habitat that have been lost due to the ongoing aggradation of the historic Salt River channel. The project consists of the following four major components:

- **Salt River Channel and Riparian Floodplain Restoration** – Restoration of hydraulic capacity, in-stream fish habitat, riparian vegetation, and improved water quality in the entire Salt River and its tributaries. The channel design for this option optimizes fish passage, riparian habitat, and sediment transport.
- **Tidal Wetland and Upland Restoration** – Restoration of the Riverside Ranch property located near the confluence of the Salt River and the Eel River. Portions of the property would be restored to open water, salt marsh, and other wetland types. Some acreage would continue to be agriculturally managed to create suitable habitat for Aleutian geese.
- **Upslope Sediment Reduction** – Sediment reduction/erosion control actions in the sub-watersheds, including upslope channel restoration, riparian planting, bank stabilization, livestock fencing, and road drainage upgrades. Projects may also include engineered natural features to capture and trap sediment in off-channel areas that would gradually be restored to wetland areas. These efforts would improve the quality of Salt River water and hydrologic function by reducing turbidity, sediment load, and sediment deposition.
- **Adaptive Management Plan** – Project performance thresholds and acceptable practices would be developed for future adaptive management measures to maintain performance of the overall Salt River Ecosystem Restoration Project.

Through these actions, the project will reconnect the Eel River Estuary with the Salt River channel and its upslope watersheds. In total, 7.7 river/riparian corridor miles and 444 acres of tidal wetland habitat will be restored.

Success Factors:

Many factors have contributed to the success of this FM/IWM project. Several unique factors are discussed here.

Transparency: Project proponents attribute the sustained success of this project to the open and transparent process. This approach contributed to common understanding of the problems being addressed, identification of an integrated solution, and understanding of the associated benefits and costs of that integrated solution. This transparency also contributed to the support and participation of interested parties and stakeholders that grew over the course of the project.

Permitting Approach: One of the biggest challenges faced by project proponents was working through the permitting process. The SRAG employed a work group approach for coordinating permit requirements of the individual components of the FM/IWM project. The work group approach enabled the project proponents to describe the integrated solution, providing better context for the regulatory permitting agencies. Through this coordinated approach conflicts and opportunities were identified and a resolution to a majority of the permitting questions was reached in a timely and effective manner.

Role of the responsible agency, HCRCD: HCRCD recognized early on that this was a community project and that it required the involvement and commitment of all interests affected by, and beneficiaries to, the solution. HCRCD defined its role as an advocate and resource for these project interests and has consistently served in that capacity for the duration of the project development.

Integrated Management Actions

Anticipated project activities include channel dredging and/or excavation, establishment of active and passive sediment management areas along the channel, extensive revegetation throughout the project footprint, tide gate modification and/or removal, channel realignment, wetland restoration, construction of setback berms and regrading of existing levees on Riverside Ranch, spoils transport, staging, placement, and reuse as an agricultural amendment, erosion control projects in the upper watershed, and future adaptive management projects for project maintenance.

Integrated Benefits

The Salt River Ecosystem Restoration Project is a watershed-based, ecosystem-scale project with multiple objectives and benefits. The project's primary benefits are for reduction of chronic flooding and ponding for long durations, fish and wildlife habitat restoration and enhancement, water quality improvement, and carbon sequestration. The project will provide immediate and substantial improvements to the watershed, facilitate improved agricultural production, and restore natural hydrologic and ecological processes.

Financial Information and Project Status

Construction of the Salt River Ecosystem Restoration Project is proceeding in two major phases. Phase 1 consists of wetland and upland restoration of the Riverside Ranch property and excavation and reconfiguration of approximately 1.5 miles of Salt River channel. Plans and specifications are 95 percent complete and construction is expected to start in the summer of 2012. Phase 2 consists of excavation and reconfiguration of an additional 5.5 miles of Salt River channel. Plans and specifications for this phase are 50 percent complete, and construction will follow completion of Phase 1 construction. The project also includes an adaptive management plan for the long-term maintenance of the Salt River channel and Riverside Ranch restorations. The estimated total project construction cost (Phases 1 and 2) is $17,101,000.

The Salt River Ecosystem Restoration Project and its project components have received funding from various sources, including:

- DWR Flood Corridor Grant Program: $3,000,000 (draft recommendation)
- DWR IRWMP Grant Program: $1,169,000 (sub-agreement of grant award to County of Humboldt – North Coast Integrated Regional Water Management Plan)
- State Water Resources Control Board Proposition 50 Grant Program: $5,000,000
- CDFW Fisheries Restoration Grant Program: $551,551
- California Department of Transportation (Caltrans) Environmental Enhancement and Mitigation Program: $350,000
- NRCS Wetland Reserve Program: $1,700,000
- USFWS National Coastal Wetlands Conservation: $1,000,000.
- USFWS North American Wetlands Conservation Act: $400,000.
- Wildlife Conservation Board: $1,000,000.
- NOAA: $760,343.
- Estuary Restoration Act via U.S. Army Corps of Engineers: $800,000

This totals approximately $15.7 million (current and pending) in funding.

Primary Information Sources

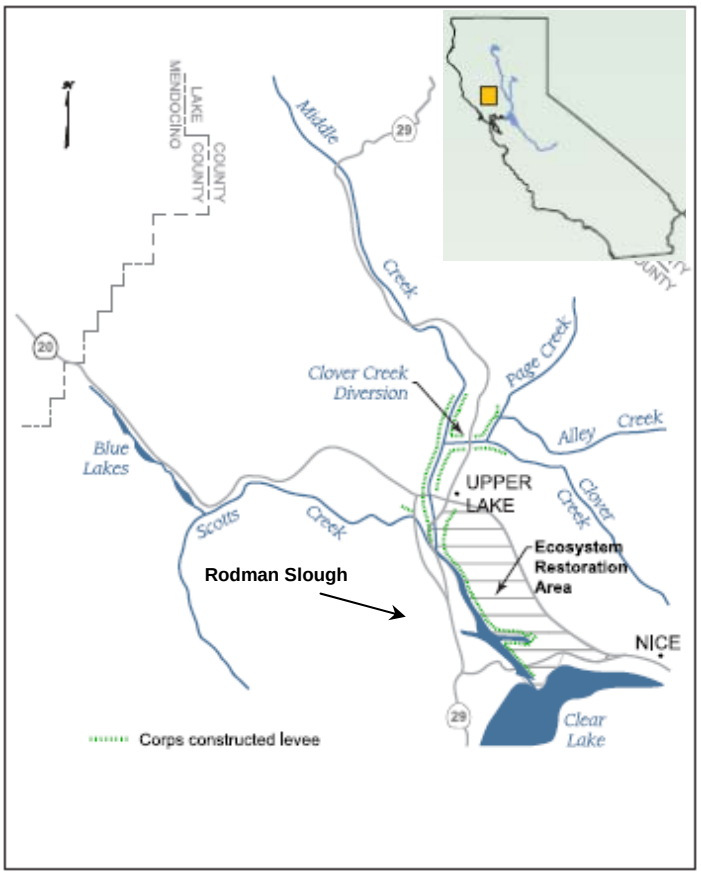
Humboldt County Resource Conservation District. *Final Environmental Impact Report: Salt River Ecosystem Restoration Project.* February 2011.

Humboldt County Resource Conservation District. *Project Summary* (unpublished). January 2012.

Humboldt County Resource Conservation District. *Salt River Ecosystem Restoration Project Adaptive Management Plan.* January 2011.

Project Name: Middle Creek Flood Damage Reduction and Ecosystem Restoration Project

Responsible Agency	Lake County Watershed Protection District
Partners	The Middle Creek Flood Damage Reduction and Ecosystem Restoration Project (Middle Creek Restoration Project) was developed through collaboration between the District and multiple agencies. The District is developing partnerships to assist in completion of the Project. Current and potential partners include: • U.S. Army Corps of Engineers (USACE) • Central Valley Flood Protection Board • California Department of Fish and Wildlife (CDFW)/Wildlife Conservation Board • California State Water Resources Control Board • Central Valley Regional Water Quality Control Board • California Bay-Delta Authority • California Department of Water Resources (DWR) • Local Native American Tribes • Lake County Special Districts • Nonprofit organizations The District is also cooperating with the U.S. Department of Agriculture (USDA) Forest Service, USDA NRCS, the U.S. Department of Interior Bureau of Land Management, East Lake and West Lake Resource Conservation Districts, and local watershed groups in support of the Middle Creek Project and to improve management of Clear Lake watershed.
Region/County	Sacramento River Region/Lake County
Project Area	



Source: California Department of Water Resources, *Middle Creek (Flood Damage Reduction and Ecosystem Restoration Project) Fact Sheet*, October 2011.

The Middle Creek Restoration Project is located at the north end of Clear Lake, Lake County, California (about 90 miles north of San Francisco), in the area bounded by State Highway 20 and Rodman Slough. Clear Lake is a large, natural, shallow, eutrophic lake and is the headwaters of Cache Creek (a tributary of the Sacramento-San Joaquin Delta). The Scotts Creek and Middle Creek watersheds, which comprise approximately one half of the Clear Lake watershed, drain through Rodman Slough adjacent to the Middle Creek Restoration Project area. These two watersheds provide 57 percent of the inflow and 71 percent of the phosphorus loading to Clear Lake. Fourteen hundred acres of reclaimed[1] wetlands are located in the Middle Creek Restoration Project area. Areas adjacent to the project are a mixture of agricultural lands, rural residences, and small communities (Upper Lake and Nice).

Problems and Need

The Clear Lake watershed has faced numerous problems over the last 20 to 30 years. The most significant issues include flooding, water quality, and habitat degradation.

Flooding: As was the custom of the era, the Middle Creek Restoration Project area was reclaimed between 1900 and 1940 by constructing levees, creating a slough and reclaiming approximately 1,200 acres of lake bottom and shoreline wetlands for agricultural purposes. In 1958, USACE added to the levee system, reclaiming an additional 200 acres of shoreline wetlands. Completed in 1966, the original Middle Creek project added 14.4 miles of levees on Middle Creek and Scotts Creek.

Having settled up to 3 feet below design grade, the levees in the Middle Creek Restoration Project area are particularly prone to failure during a major flood event. Key levee hazard factors include slope stability and inadequate cross-section geometry. The pump station is 49 years old and in need of major repairs, primarily due to age and levee settlement. USACE has determined that the levees provide a 4-year level of protection (the levees were originally designed to provide a 50-year level of protection) and will overtop during a 35-year flood event without emergency floodfight measures.[2] The area was evacuated in 1983, 1986, and 1998, with evacuation imminent in 1995. Reconstruction of the levees is estimated to require in excess of $64 million. Since the reconstruction costs would exceed the estimated flood damage reduction benefits received, neither the State nor Federal government is authorized to participate in the repair of the levees.

View from degraded levee looking northeast past pumping plant. Area beyond pump house proposed to be flooded.

Water quality and habitat degradation: Reclamation of wetland areas to support development in the Clear Lake watershed significantly impaired water quality, and freshwater marsh and riparian habitat. Significant decline in Lake water quality has resulted in increased biological productivity in the lake with frequent blue-green algal blooms in the late summer months. The U.S. Environmental Protection Agency (EPA) Clean Lakes Diagnostic/Feasibility Study completed in 1994 for Clear Lake concluded that sediment nutrients are primarily responsible. The study recommends numerous actions to reduce the frequency and magnitude of the blue-green algal blooms, including erosion control and wetland and riparian restoration.

Flood Hazard Type

Type(s): Slow Rise Flood

Clear Lake and its tributaries have a long history of flooding. Flooding along Clear Lake's shoreline (including the historic floodplain of Middle Creek) is primarily caused by high lake inflows in conjunction with limited outflow. As a consequence, excess runoff must be stored in the lake causing lake levels to rise. Because of the discharge capacity, lake stages can remain above flood level for many days, sometimes months.

[1] Reclamation is the process of creating and protecting lands susceptible to overflow from ocean and bodies of fresh water, such as seas, lakes, rivers, and their tributaries.

[2] U.S. Army Corps of Engineers, Office of the Chief of Engineers. Middle Creek, Lake County, California, Flood Damage Reduction and Ecosystem Restoration, Final Chief of Engineers' Report. November 29, 2004.

Solution

The Middle Creek Restoration Project would restore the largest damaged wetland located at the base of the largest sediment source within the watershed. This would require restoration of 765 acres of wetlands and floodplain that were previously isolated from Clear Lake. Flooding, water quality, and habitat issues discussed above were first addressed with an integrated, watershed approach in the 1990s with the formation of the Clear Lake Basin Resource Management Committee (renamed the Lake County Coordinating Resource Management Committee). Efforts by the committee include developing a Clear Lake watershed management plan and support for the Middle Creek Restoration Project.

The Middle Creek Restoration Project will reconnect Scotts and Middle Creek to historical floodplains by acquiring previously reclaimed land, and breaching the existing levee system along Rodman Slough to create inlets that direct flows into the historical floodplain.

Significant land acquisition will be required, including relocation of up to 18 residential structures. The CDFW prepared a Draft Clear Lake Wildlife Area Conceptual Area Protection Plan, which included acquisition of all of the property required for the Middle Creek Restoration Project. If the CDFW proceeds with the Conceptual Area Protection Plan, the District will work closely with CDFW to meet the mutual goals of each agency.

View looking downstream Rodman Slough. Photographer standing on the substandard levee proposed to be breached.

The entire Middle Creek Restoration Project area will be restored to a natural habitat consisting of open water, freshwater emergent wetlands, riparian zones and upland habitat (oak woodland). The historical floodplain at the mouth of Scotts Creek and Middle Creek will be restored. Because Clear Lake will inundate the Middle Creek Restoration Project area, the natural hydrology of a lacustrine, freshwater wetland will be restored. In addition to restoration of fish and wildlife habitat values, the wetland area will provide water quality benefits of sediment, phosphorus and nitrogen removal from the water column. Channels will be excavated to direct the flow of water from Middle Creek and Scotts Creek through the Middle Creek Restoration Project area, thereby improving the quality of water (sediment and phosphorus removal) that enters Clear Lake from their watersheds. In addition, the denitrification (the conversion of nitrogen to nitrogen gas) of lake water during the summer may provide some additional water quality benefits.

Success Factors:

Multiple, watershed-wide benefits: This project is anticipated to have multiple benefits not only onsite but also for the entire Clear Lake watershed. While the project could have potential negative effects for a range of watershed stakeholders, the integrated approach provides an opportunity to mitigate most, if not all, of these effects.

Collaboration: Many factors are required for this project to be successful. One important factor is the high degree of collaboration among multiple landowners, public and private entities, as well as funding partners. The Lake County Watershed Protection District is forming partnerships with various interested parties to meet the cost-share conditions for implementing the project.

Integrated Management Actions

The Middle Creek Restoration Project will encompass integrated structural and nonstructural actions to achieve multiple benefits. The primary actions are summarized below.

Flood damage protection measures include:

- All property within the 100-year floodplain will be acquired in fee, structures will be demolished and/or relocated, infrastructure will be removed or floodproofed, and the existing substandard levees will be breached to allow the area to reflood in a passive manner.
- Rock slope protection and native vegetation will be used to minimize erosion in the Middle Creek Restoration Project area. Small areas at the levee breaches have been proposed to be lined with riprap to prevent erosion.

Restoration measures include:

- The levees will be breached to allow water to automatically flow in and out of the Middle Creek Restoration Project area. The breaches will also serve as fish and wildlife passage areas.
- Native wetland, riparian, and brush/woody vegetation will be planted in the Middle Creek Restoration Project area.
- Floodplain habitat will be enhanced by creating islands using material excavated from the levee breaches and created channels. The island habitats will provide refuge for small mammals during the winter and breeding sites for birds. Also, the remaining unused levees will be restored as islands.
- Channels, sloughs, and ponds similar to those that existed prior to 1920 will be created. They will be excavated prior to flooding of the Middle Creek Restoration Project site, which will enable the use of conventional construction equipment.

Integrated Benefits

The Middle Creek Restoration Project will decrease flood damages, provide open water and riparian habitat for fish and wildlife, including special-status species, and improve water quality. Specific integrated benefits of the project are discussed below.

Flood damage reduction benefits:

- Reduce flood risk by removing structures and property at risk of severe flooding as a result of levee failure. There are 18 homes and numerous outbuildings subject to flooding should the levees fail. Approximately 765 acres of agricultural land would be flooded. Because flood depths are large (more than 5 feet in most locations) and would occur for extended periods, potential flood damages are high.
- Protect more than 3 miles of public roads and a major high-voltage Pacific Gas and Electric transmission line that cross the Middle Creek Restoration Project area, all of which are currently vulnerable to flood damage, by elevating or retrofitting the existing structures.
- Remove approximately 3 miles of substandard levees, one pumping station and one weir structure associated with these existing facilities. DWR, the agency that maintains the Middle Creek flood management facilities, would experience a reduction in operation and maintenance (O&M) costs ($110,000 to $160,000 per year) and emergency response costs (estimated in excess of $300,000 per major flood event for DWR and cooperating State and Federal agencies).

Water quality benefits:

- Sediment is the primary nutrient source (97 percent of Clear Lake's total phosphorus load is sediment bound) contributing to eutrophication of Clear Lake that produces algae bloom. It has been estimated that the current sediment and phosphorus load is twice the pre-European settlement sediment load. Approximately 71 percent of the sediment and phosphorus entering Clear Lake is from Scotts and Middle Creek watersheds. The Middle Creek Restoration Project is estimated to remove up to 40 percent of phosphorus entering Clear Lake from these two creeks. Reduced phosphorus concentrations in Clear Lake would potentially reduce the chlorophyll concentrations by 33 percent. A corresponding reduction in total organic carbon would also be realized.
- Wetlands are known to efficiently remove nitrogen from the water column. Because the Middle Creek Restoration Project area is hydraulically connected to Clear Lake, it would provide some nitrogen removal benefits to Clear Lake. The extent of these benefits is unknown and has not been quantified.
- Improved water quality in Clear Lake will reduce the cost of treating lake water to drinking water standards.
- Recreation and tourism will be enhanced by improving the water quality in Clear Lake. In 1994, the USDA Soil Conservation Service estimated that $7 million in tourism is lost annually due to water quality issues in Clear Lake.

Habitat benefits:

- Restore up to 1,400 acres of the 7,520 acres of historical wetlands in the Clear Lake Basin that have either been lost or severely impacted. This is a 79 percent increase in the Basin's existing wetland habitat. Of the historical 9,300 acres of freshwater wetlands that existed in the Clear Lake Basin, approximately 7,520 acres (80 percent) have been lost or severely impacted. Restored habitat includes open water, seasonal wetlands, in-stream aquatic habitat, shaded aquatic habitat, and perennial wetlands. Additional upland habitat will be protected adjacent to the wetland and stream areas.
- Provide a significant increase in habitat for fish and wildlife. The Middle Creek Restoration Project would greatly improve the bird-nesting habitat and increase the available spawning habitat for native and non-native fish. The area is currently used extensively by migratory waterfowl.
- Preserve the fish and wildlife resources and the cultural resources in the project area.

- Several special-status wildlife species could benefit from the creation of wetland, open water, and riparian habitats in the expanded floodplain. Some species include the northwestern pond turtle, American white pelican, double-crested cormorant, western least bittern, osprey, white-tailed kite, bald eagle, northern harrier, Cooper's hawk, American peregrine falcon, California yellow warbler, yellow-breasted chat, tricolored blackbird, fringed myotis, long-eared myotis, long-legged myotis, pallid bat, and Townsend's western big-eared bat.

Other potential benefits:

- Improve vector control in the area. The Middle Creek Restoration Project would introduce a diverse wetland and riparian community in place of several hundred acres of rice fields and flood-irrigated pasture. The presence of natural predators may result in lower insect populations in the area.
- Potential conservation of water supply. Initial estimates by Lake County Watershed Protection District indicate the Middle Creek Restoration Project could increase Clear Lake storage by 5,900 acre-feet. The restoration of the Middle Creek floodplain is expected to have positive effects upon water supplies, including increased surface water storage and groundwater recharge. However, restoration might negatively affect water supplies by increased evaporation from surface water surfaces and likely greater consumptive use (wetlands compared to existing agricultural uses). Further hydrologic studies are planned to better assess how the Middle Creek Restoration Project affects water supply.

Financial Information and Project Status

In 1995, Lake County requested USACE to assist in evaluating the Middle Creek Restoration Project to reduce flood risk and to improve water quality. USACE undertook the Middle Creek Restoration Project under the Environmental Restoration Authority, where it is authorized to provide up to 65 percent of the construction cost. In May 1997, the USACE completed a Reconnaissance Study that concluded that the Middle Creek Restoration Project was practical and that a Federal interest existed to pursue it further. In June 1999, the USACE began a Feasibility Study concurrent with an environmental impact statement (for Federal compliance) and environmental impact report (for State compliance). These documents were completed in 2003 and 2004, respectively. Six alternatives were evaluated. A singular flood damage reduction project was not cost effective. The most beneficial project was determined to be an integrated approach addressing flood risks, habitat improvements, and other benefits. The Middle Creek Restoration Project was authorized by the Water Resources Development Act in November 2007. After review of the Federal document for compliance with the National Environmental Policy Act, the U.S. Fish and Wildlife Service (USFWS) requested a survey of the red-legged frog and an evaluation of potential methyl mercury impacts. The completed studies are awaiting formal approval by the USFWS. Design work, originally scheduled for completion in 2010, has been postponed pending this approval. In addition, limited Federal funds have been appropriated, and additional funds are needed to complete the design. Construction of the Middle Creek Restoration Project, originally planned for 2012 through 2015, has similarly been delayed.

In August 2003, the Lake County Watershed Protection District was awarded a $5.214 million grant by DWR to begin acquiring residential properties within the Middle Creek Restoration Project area. In December 2006, the grant amount was increased to $5.714 million. The appraisal process began in September 2004, with property acquisitions ongoing. It is anticipated that eight or nine of the most flood-prone residential properties can be acquired with these funds, once funds are released. As of November 2008, seven parcels have been acquired. In December 2008, the funds were frozen by the State, with no estimate of when the funds will be made available. The Lake County Watershed Protection District purchased and demolished one additional residential parcel using District funds in 2009-2010. Five additional parcels are currently being appraised for purchase, with additional parcels soon to enter the appraisal process. A grant amendment for an additional $4 million dollars to acquire homes is currently being processed.

Under current funding guidelines, approximately 35 percent of the costs for future phases of the project are the responsibility of Lake County Watershed Protection District. These costs are beyond the District's ability to pay, and the District is currently developing partnerships (see Partners section above) to assist in completion of the Middle Creek Restoration Project.

The most recent project costs, including engineering, design, and construction, is estimated by the USACE based on October 2006 price levels as follows:

- Federal Share $31,300,000
- Non-Federal Share $16,700,000
- Total Cost $48,000,000

Primary Information Sources

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U.S. Army Corps of Engineers, Sacramento District. *Middle Creek, Lake County, California, Flood Damage Reduction and Ecosystem Restoration, Final Integrated Feasibility Report and Environmental Impact Statement/Environmental Impact Report.* September 2002, revised October 2003.

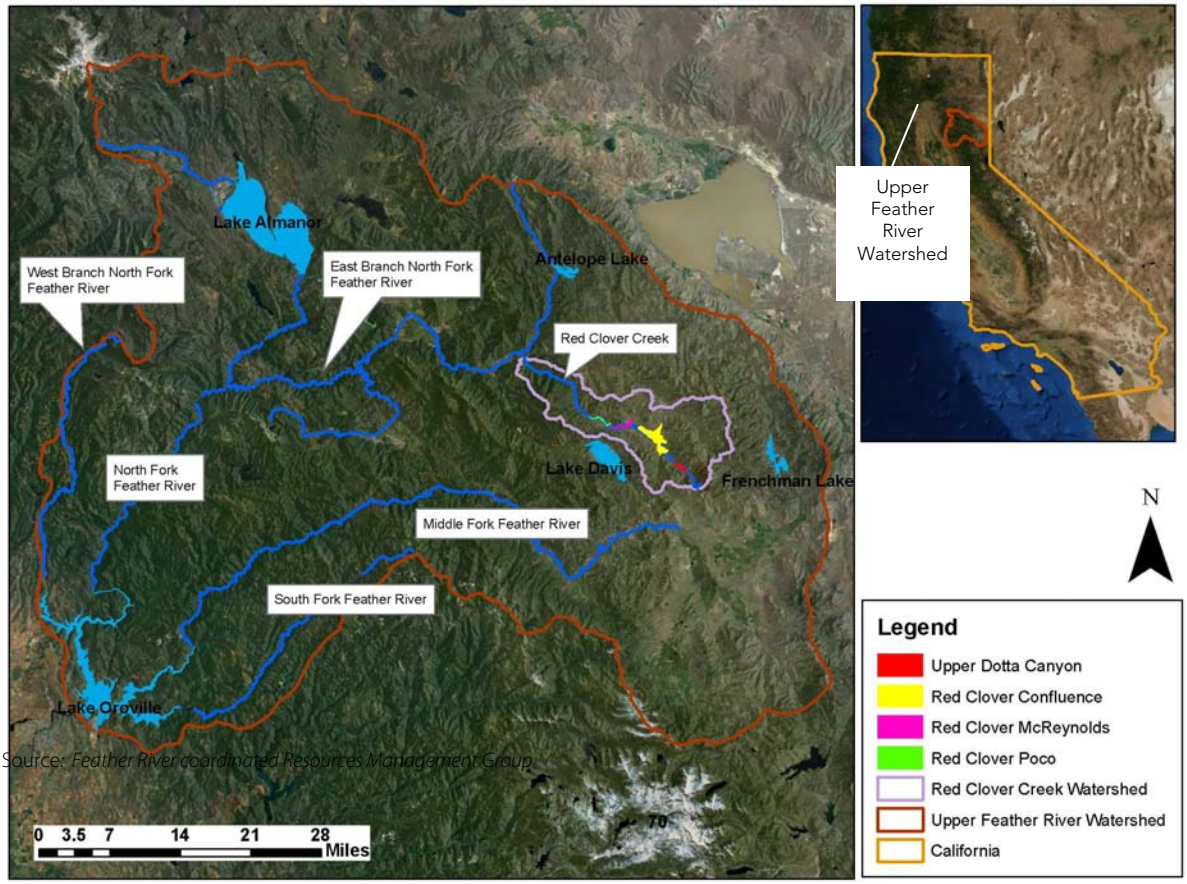
Project Name: Red Clover Creek Restoration Projects

Responsible Agency	Plumas Corporation and the Feather River Coordinated Resource Management (FRCRM) Group
Partners	Red Clover Creek restoration efforts are being directed by the FRCRM group. This group, formed as an alliance in 1985 to work on watershed restoration, is a consortium of the following 24 public and private sector groups: • California Department of Forestry and Fire Protection • California Department of Fish and Wildlife • California Department of Water Resources (DWR) • California Regional Water Quality Control Board • California Department of Conservation • Feather River College • North Cal-Neva Resource Conservation and Development District • Pacific Gas and Electric Company • Feather River Resource Conservation District • Plumas Unified School District • Plumas Corporation • U.S. Forest Service, Plumas National Forest • Trout Unlimited • U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS) • U.S. Army Corps of Engineers (USACE) • U.S. Fish and Wildlife Service (USFWS) • California Department of Transportation (Caltrans) • California Department of Parks and Recreation • Plumas County Community Development Commission • University of California Cooperative Extension • Salmonid Restoration Federation • USDA Farm Services Agency • Plumas County • Sierra Valley Resource Conservation District The primary partnership mechanism is the Memorandum of Understanding for Coordinated Resource Management executed for the upper Feather River watershed. Enabled by Federal statute, this collaborative, consensus-based process has allowed for effective collaboration and support from numerous public and private entities within the watershed. Additionally, each project has a project agreement, typically for 10 years, that outlines the roles and responsibilities for management, monitoring, and maintenance for the various project partners. USACE was a founding signatory member of the FRCRM group. Originally, USACE participated in FRCRM meetings to provide technical and regulatory input. Currently, USACE is inactive as a direct participant, but it still has regulatory jurisdiction over all projects through the permitting process.
Region/County	Sacramento River/Plumas County
Project Area	
The upper Feather River watershed straddles the northern Sierra Nevada Range between the Great Basin Desert and the Central Valley of California. This watershed has long been recognized for its recreational and aesthetic value. Water originating from its drainages represents a significant component of the State Water Project and provides high-quality water for hydropower generation, agriculture, industry, and cities. Since the inception of the FRCRM group, more than 50 watershed projects have been completed, including studies and assessments, stream restoration, monitoring, resource management plans, strategic planning,	

community outreach, and educational activities. This case study describes four ongoing and proposed projects within the Red Clover Creek watershed as a group, since they address the common problem in the upper Feather River watershed of channel erosion and incision, resulting in disconnection of the channel from its floodplain and dewatering of the adjacent meadow. These featured projects are:

- Red Clover/McReynolds Creek Restoration Project (completed 2006)
- Red Clover Poco Restoration Project (completed 2010)
- Red Clover Confluence Project (proposed)
- Upper Dotta Canyon Restoration Project (proposed)

The projects are located in Red Clover Valley, approximately 60 miles north of Truckee and 30 miles east of Quincy in Plumas County. Red Clover Valley is 13 miles long, up to 2 miles wide, and has a drainage area of 75 square miles. The McReynolds Creek portion of the project extends north from its confluence with Red Clover Creek approximately 5,000 linear feet upstream. The cumulative watershed area is 82 square miles from the confluence of the two creeks. The Dotta Canyon project is located in the upper reaches of Red Clover Valley.



Source: *Feather River Coordinated Resources Management Group*

Problems and Need

Watershed degradation and erosion: The Feather River watershed has been impacted by more than 140 years of intense human use. Past mining, grazing, and timber harvesting practices; wildfire; and railroad and road construction, along with several damaging floods (in 1955, 1986, and 1997), have contributed to the degradation of over 60 percent of the watershed, resulting in accelerated erosion, degraded water quality, decreased vegetation and soil productivity, and reduction in the productivity and diversity of fish and wildlife populations in the Feather River and tributary streams.

Water quality and ecosystem impacts: The Red Clover Creek watershed historically has been used for grazing and logging, with an extensive road and historical logging railroad grade system. This stream system also had a reputation as an outstanding trout fishery. Continuing disturbance over time initiated moderate to severe incision (downcutting) of the stream channels throughout Red Clover Valley, resulting in extensive gully networks that have lowered the shallow groundwater tables in the valley meadow, concurrently changing the plant communities, and increasing the sediment supply. In turn, this has resulted in a loss of meadow productivity, diminished summer flows, and severe bank erosion. This erosion contributed large amounts of sediment to the

North Fork Feather River system via Indian Creek. Due to severe channel incision and bank erosion, the Red Clover Creek watershed channel system was determined to be the third highest sediment-producing subwatershed in the East Branch North Fork Feather River watershed (*East Branch North Fork Feather River Erosion Inventory Report*, USDA - Soil Conservation Service, 1989). Annually, 1.1 million tons of sediment are delivered to Rock Creek Dam at the downstream end of the East Branch North Fork Feather River, of which 80 percent is attributable to human activities.

Flooding: Upper watershed degradation resulted in local and regional flood management issues. The stream channels have become disconnected from the floodplains, eliminating the buffering capacity of the floodplain. This results in flooding of lands at downstream locations where hydraulic capacities are limiting. Furthermore, bank erosion results in heavy sediment loading downstream and impacts flood management operations in downstream reservoirs, such as Oroville reservoir, which provides water supply, recreation, hydropower, and flood protection for downstream areas.

Flood Hazard Type

Types: Debris Flow and Alluvial Flooding

Solution

Since inception, the FRCRM has known that mountain meadows play a key role in affecting watershed condition and water flow in the northern Sierra Nevada. Restoration of degraded meadows is the first step in improving overall watershed function and could have major effects on surface and subsurface flow regimes, which influence water delivery downstream.

The FRCRM restoration efforts evolved from a project-level scale to a systematized, coordinated, long-range resource restoration and management system conducted on sub-watershed, watershed, and landscape scales. The four Red Clover Creek projects share the same watershed restoration goal of stabilizing stream channels to address erosion, improve water quality, increase summer base flows for priority species and beneficial uses, restore floodplain habitat, and reduce impacts to downstream water supply and flood management.

The four restoration projects in Red Clover Valley were implemented in a step-wise approach for practical reasons, such as locations within the watershed with the most pressing issues, lands with willing land owner participants, and funding limitations. By taking this step-wise approach, the FRCRM group can monitor and quantify benefits, educate the public, provide technology transfer, and over time, tackle the issues within the entire valley.

The scope of the Red Clover Creek restoration projects include eliminating the existing gullies within the project area, restoring bank-full flows to the historical remnant channel(s) on the surface of the meadow, restoring floodplain function, decreasing water temperatures, reducing sedimentation, improving forage production for cattle, improving fish and wildlife habitat, and improving long-term stability of the channel/floodplain system.

The pond-and-plug technique is used to address floodplain function as the fundamental precursor to all other project objectives. This technique replaces miles of entrenched, gullied channels on both private and public lands with a series of plugs that effectively eliminate the gully as a drainage feature on the landscape. The plug material comes from the edges of the gully, in between plugs. The pond-and-plug technique is an economically feasible and proven technique to restore a channel to the meadow floodplain elevation. The specific actions include:

- Excavation of fill material from the gully to build plugs, resulting in creation of ponds that fill with groundwater
- Rock fill for grade control structure (if necessary)
- Redirection of flows from the gully into an existing remnant channel on the meadow
- Installation of new pasture fencing and offsite water supply on private land
- Cattle guard installation on local roads
- Monitoring and management

Overall, restoration activities play an important role in accelerating improvement in watershed function, the local economy, and downstream uses. Public education is also an essential element to the success of FRCRM programs. Plumas County's watershed management initiatives, such as the Upper Feather River Watershed Integrated Regional Water Management Plan (2005), provide the foundation for larger-scale water management and planning.

Red Clover Creek – Before Restoration (Source: *Red Clover/McReynolds Creek Restoration Project*)

Red Clover Creek – Restored (Source: Red Clover/ McReynolds Creek Restoration Project)

Success Factors:

Many factors have contributed to the success of this FM/IWM project. Several unique factors are discussed here.

After 25 years and completion of 60 restoration projects, the FRCRM has experienced that the once-full floodplain function has been restored, other project objectives are more effectively achieved because in a riparian ecosystem, they are inextricably linked.

The suite of projects undertaken or planned for Red Clover Valley have required a high degree of collaboration among multiple landowners, public and private, as well as funding partners. The FRCRM group has also formed partnerships with academia to improve the science of restoration projects and better understand watershed processes.

Scaling the pond-and-plug technology to the landscape scale has required continuous adaptive management to address highly variable landscape settings/conditions. Historical and current watershed effects are taken into consideration in the design and implementation process via watershed analysis. In addition, emphasis has shifted from a "project-of-opportunity" approach to a strategic approach that provides for long-term watershed maintenance in the highest priority areas at the right time.

The challenges of working at the landscape scale are numerous. Agencies and watershed stakeholders, particularly downstream water right holders, have expressed reservations/concerns over the scale and pace of project implementation relative to ability of the research and monitoring to effectively determine change, if any. Multiple funding opportunities exist; however, grant caps, match requirements, and differing grant program objectives make securing funding a relatively onerous process.

Integrated Management Actions

The main actions implemented for the Red Clover Creek restoration projects include the following:

- Floodplain reconnection
- Pond-and-plug
- Redirect flow into remnant channel
- Riparian revegetation

Integrated Benefits

Stabilized stream channels to address erosion, improved stream conditions, increased summer base flows for priority species and beneficial uses, restored floodplain function and habitat, waterfowl and wetland enhancement, reduced turbidity, reduced impacts to downstream water supply and flood management.

Financial Information and Project Status

The Advanced Project Planning List by the FRCM Group, Plumas Corporation includes potential projects that are currently in some phase of analysis. Of the projects in Red Clover Valley discussed in this FM/IWM case study, the Red Clover/McReynolds Creek Restoration Project and the Red Clover Poco Restoration Project are complete and are currently being managed and monitored. The Dotta Canyon Project is scheduled for implementation in July or August 2012. The Red Clover Confluence Project is in the project development and design phase and is on hold until additional funding is secured.

The Red Clover Valley projects discussed here are in various stages of receiving and securing funding. The funding status for each project is described below:

- The Red Clover/McReynolds Creek Restoration Project primary funding ($1,101,000) was provided through the State Water Resources Control Board (SWRCB) Proposition 13 CALFED Watershed Program, with

contributions from DWR, Natural Resources Conservation Service, U.S. Forest Service-Plumas National Forest, the landowner, and volunteers.

- The Red Clover Poco Restoration Project primary funding ($1,169,650) was provided through the SWRCB Proposition 13 and Proposition 50 Watershed Protection Grant Program, with contributions from DWR, Point Reyes Bird Observatory Conservation Science, Plumas Audubon, Herger-Feinstein Quincy Library Group, U.S. Forest Service-Plumas National Forest, and volunteers.
- The Upper Dotta Canyon Restoration Project is to be funded by USACE Sacramento District Wetland Conservation fund, Natural Resources Conservation Service Environmental Quality Incentives Program, and California Proposition 13 and 50 water bond funds.
- Initial project development funding support for the Red Clover Confluence Project was from Plumas County Resource Advisory Committee Secure Rural Schools Act Public Law 110-343 and the landowner. Further funding is under development.

Primary Information Sources

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Feather River Coordinated Resource Management Group, Plumas Corporation. *Advanced Project Planning List*. January 15, 2012.

Feather River Coordinated Resource Management Group, Plumas Corporation. Personal communications with Gia Martynn, Watershed Coordinator. February 2012.

Feather River Coordinated Resource Management Group. Project Locations Map, showing projects that provide flood management benefits. Undated.

Feather River Coordinated Resource Management Group. Completed Projects and Costs List. Undated.

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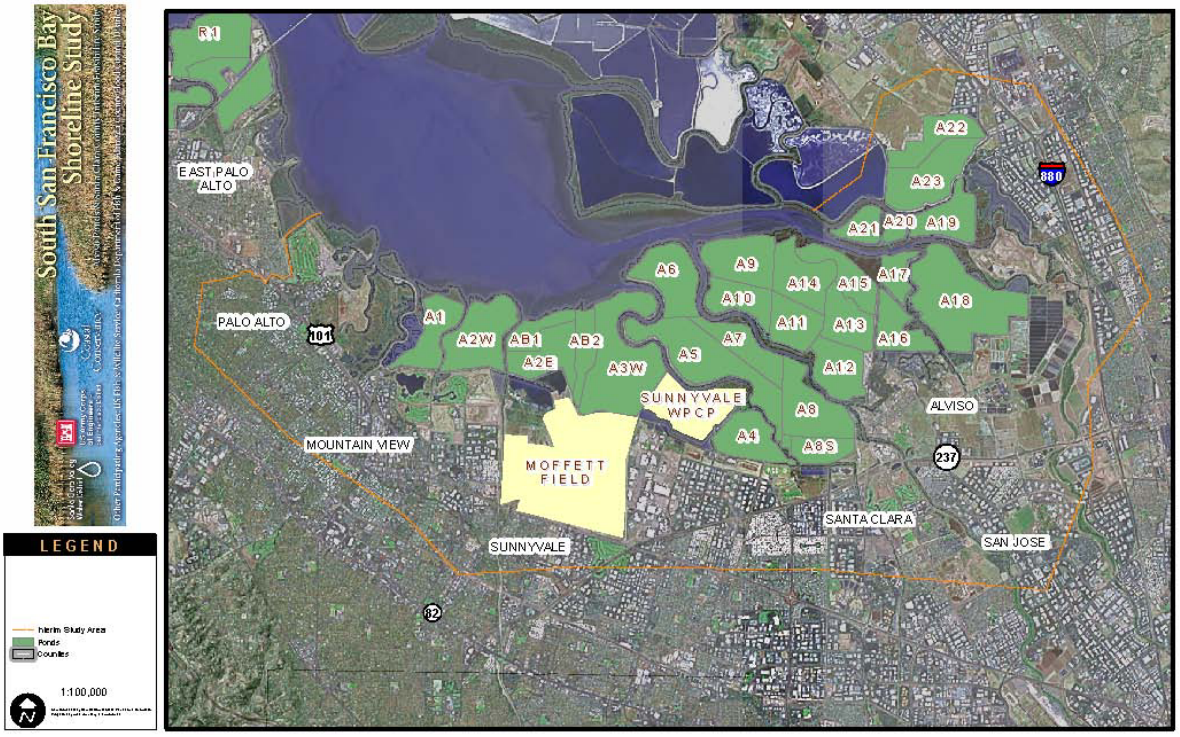
Project Name: South San Francisco Bay Shoreline Project

Responsible Agency	U.S. Army Corps of Engineers (USACE)
Partners	California State Coastal Conservancy (Conservancy) Santa Clara Valley Water District (SCVWD) U.S. Fish and Wildlife Service
Region/County	San Francisco Bay/Santa Clara, San Mateo, and Alameda counties

Project Area

The South San Francisco Bay Shoreline Study (Shoreline Study) is located in the southern part of the San Francisco Bay Area (South Bay) and encompasses three former salt production pond complexes and adjacent shoreline areas. The entire South Bay salt pond complex is spread over an area of approximately 26,000 acres and surrounds nearly the entire San Francisco Bay south of the San Mateo Bridge on lands that were formerly tidal marsh. Current planning efforts are focused on a subset of ponds within the Alviso Pond Complex in Santa Clara County and the community of Alviso.



Source: www.southbayshoreline.org, accessed April 4, 2012

Problems and Need

Flooding: The study area has a history of fluvial flooding and is at risk of tidal flooding due to projected sea level rise and historic subsidence, which has resulted in portions of the study areas being 13 feet below sea level. In addition, tidal flood risk will increase if the levees surrounding the former salt production ponds are breached to restore tidal marsh.

Flood damage to communities in the area has occurred from streams tributary to the shoreline, but has been addressed by other projects. The city of Alviso was flooded by Guadalupe River in this way in 1983. Similar flood events also occurred in Alviso in 1982, 1986, and 1995.

Habitat degradation: An estimated 85 percent of the historical tidal marshes in the San Francisco Bay-Delta Estuary have been filled or significantly altered during the past two centuries for urban development, agriculture, and salt production. Habitat conditions within the estuarine ecosystem have been in a state of decline. Although dramatically different from 150 years ago, the South Bay's wetland habitats, including the salt ponds, tidal marshes, sloughs, mudflats, and open bay, are used by large populations of waterfowl and shorebirds, harbor seals, and a number of threatened and endangered species, including the California clapper rail, California black rail, California brown pelican, California least tern, western snowy plover, salt marsh harvest mouse, and steelhead trout.

Flood Hazard Type(s)

Slow rise flooding, coastal flooding, and engineered structure failure flooding.

Solution

The Shoreline Study is investigating the feasibility of a combined flood risk management and ecosystem restoration project that also provides additional public access opportunities.

Typical natural tidal marshland in San Francisco Bay near the Shoreline project area.
Source: *2012-2016 5-Year Capital Improvement Program, 2011, SCVWD*

Originally, the study encompassed all the ponds in within the study area. However, during the "without-project conditions" phase of the study, the cost and time required to model, plan, and analyze this large-sized project area proved to be much more than anticipated. To reduce costs and finish the study before the targeted implementation date of 2017, the USACE, SCVWD, and the Conservancy decided to focus on the portion of the study area that had some of the highest estimated damages from tidal flooding – the Alviso area between Alviso Slough and Coyote Creek, which includes Alviso Ponds 9 through 18.

At this time, the proposed project elements are generally:

- Tidal restoration of Alviso Ponds A9 through A15 to be phased in through adaptive management
- Tidal restoration of Alviso Pond A18 with possible creation of large upland areas and brackish marshes using treated wastewater effluent or stormwater
- Flood protection through an engineered levee system that would connect the existing high ground between Alviso Slough and Coyote Creek
- Public trails on levees and connections to the existing trail network

Various flood protection strategies will be examined, such as engineered levees, ring levees around key infrastructure, and relocation of structures within the floodplain. Proposed ecosystem restoration management actions would include breaching historical channels, lowering outboard levees, placing fill along levees to enhance upland transition zones and sea level rise resilience, placing fill as islands and deltas, and designing terraced levees to promote habitat transition zones conducive to sea level changes.

Success Factors:

- Multiple sources of funding and widespread support for the project.
- A phased project approach with an adaptive management plan integrated into the project.

Integrated Management Actions

The San Francisco Bay Shoreline Project integrates management actions to address reduction of flood risk and other resource management needs, including ecosystem restoration and enhanced recreation. Multiple benefits are achieved through this integration.

Potential management actions include: flood protection system modifications such as replacement of non-engineered levees, sloughs realignment, and stream stability improvements; levee erosion control using natural materials; improved ecosystem functions through channel breaching, lowering outboard levees, enhancing bay transition zone, and designing terraced levees and islands; floodplain management actions such as raising structures and floodproofing; targeted outreach in areas protected by levees to promote risk-reduction activities; and defining roles and responsibilities for floodplain management and emergency management.

Integrated Benefits
The future project would: 1. Reduce potential economic damages due to tidal flooding 2. Reduce the risk to public health, human safety, and the environment due to tidal flooding 3. Increase contiguous marsh to restore ecological function and habitat quantity, quality, and connectivity (including upland transition zones) 4. Provide opportunities for public access, education, and recreation
Financial Information and Project Status
The total cost of the study is approximately $19 million, and the estimated project cost is on the order of $100 - $200 million. Feasibility studies and early implementation stages are funded and underway, although design and construction phases are presently unfunded. When viewed over the long term, the inclusion of project features beyond flood protection is likely to yield a far better return on investment. USACE is currently working on developing restoration and flood protection alternatives for the Alviso area with an estimated implementation date of 2017. Flood risk management features will complete constructions within a few years, and implementation of the restoration activities will take several decades due to the phased nature of the restoration, reliance on natural processes to create tidal marsh, and potential need to adjust timing to reflect monitoring results and adaptive management.
Primary Information Sources
Santa Clara Valley Water District. *2012-2016, 5-Year Capital Improvement Program,* 2011. Study partnership website: http://www.southbayshoreline.org/

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Project Name: Lower Carmel River Floodplain Restoration and Flood Control Project

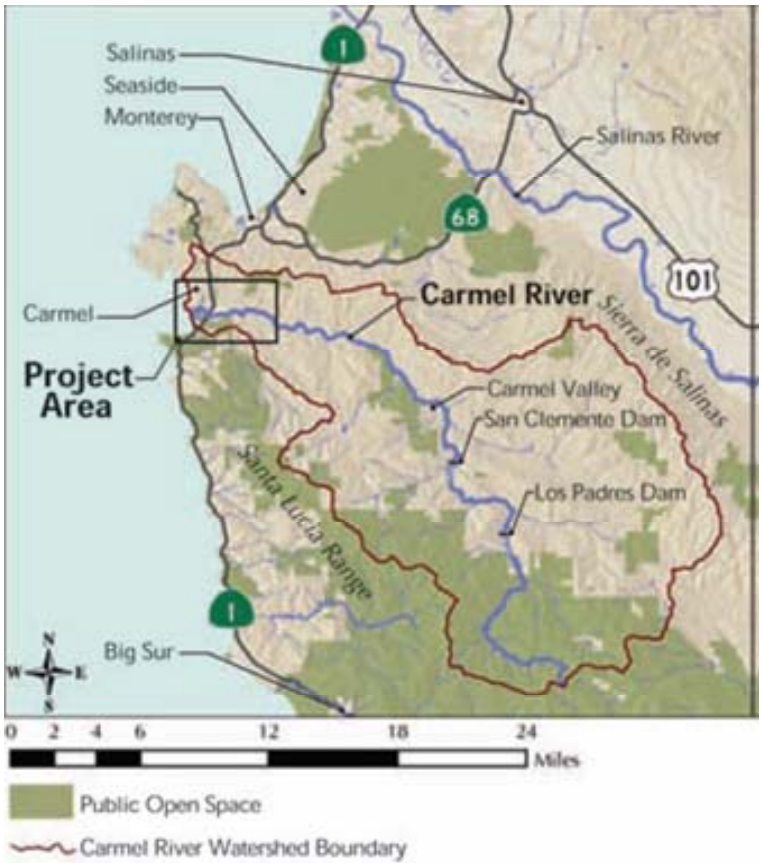
Responsible Agency	The Big Sur Land Trust (BSLT) Monterey County Water Resources Agency (MCWRA) Monterey County Public Works Department (MCPWD) California Department of Parks and Recreation (California State Parks)
Partners	The Lower Carmel River Floodplain Restoration and Flood Control Project (Carmel River Project) focuses on environmental enhancement and flood control improvements for the lower Carmel River and lagoon. These critical needs are being addressed by local agency managers, nonprofit partners, and private entities that have come together and identified several key interrelated projects, forming a comprehensive solution. These parties recognized an integrated approach was needed to effectively address flooding issues and unfavorable habitat conditions. This multiple-agency effort is taking place in three unique, but connected, areas within the lower Carmel River -- O'dello East area, Carmel River Lagoon area, and County Service Area 50 (CSA-50). These areas are described in detail in the Solutions section below. The responsible agency for each area is BSLT, MCWRA and California State Parks, and MCPWD, respectively. Other entities and interests involved with these efforts include the following: • California Coastal Conservancy (Conservancy) • National Oceanic and Atmospheric Administration Fisheries Service • Transportation Agency of Monterey County • California Department of Transportation • Carmel River Steelhead Association • Carmel River Watershed Conservancy • Monterey Peninsula Regional Park District • Carmel Development Corporation • California American Water Company • California State University at Monterey Bay • Carmel Area Wastewater District • Carmel River Lagoon Coalition • California Coastal Commission • California Department of Fish and Wildlife (CDFW) • U.S. Army Corps of Engineers (USACE) • U.S. Fish and Wildlife Service (USFWS)
Region/County	Central Coast Region/Monterey County

Project Area

The Carmel River Project is located within the lower reaches of the Carmel River watershed; the project extends from the Carmel River lagoon and river mouth to about two miles inland (see Project Area Map).

The project area includes the Carmel River State Beach and adjacent lagoon area, wetlands, and floodplain area, which together, serve as an important refuge for sensitive aquatic species and migratory birds. The project area is a dynamic interface between marine and freshwater systems.

This project area is characterized by white sand beaches, natural habitats, and agriculture, as well as residential neighborhoods, golf courses, and commercial centers.



Project Area Map

Source: *Lower Carmel River and Lagoon Floodplain Restoration and Enhancement Project Fact Sheet, Big Sur Land Trust, 2011.*

Problems and Need

Lower Carmel River and Lagoon

Source: *Lower Carmel River and Lagoon Floodplain Restoration and Enhancement Project Fact Sheet, Big Sur Land Trust,* 2011.

Human activities and infrastructure – water diversions, gravel mining, agricultural and urban development, roads, levees, bridges, and buildings– have altered the lower end of the Carmel River and impacted the watershed by redirecting flood flows, reducing floodplain acreage, and degrading wildlife habitat.

Diminished Hydrologic and Ecologic Function: The construction of State Route 1 (Highway 1) isolated floodplain areas along the lower reach of the Carmel River, diminishing the hydrologic connectivity between the river channel and adjacent floodplain. This hydrologic connectivity between the river channel and adjacent floodplain was further diminished by earthen levees constructed on the southern bank of the river that reduce flooding of adjacent farmlands. These changes contributed to repetitive flooding problems along the northern bank of the river, resulting in tens of millions of dollars in damages to residential and commercial buildings. Additionally, the isolation of floodplains from the river channel and associated expansion of agricultural land uses significantly compromised riparian and wetland habitat in the area.

Flooding and Erosion Impacts: The confinement of the main channel, as described above, redirected flood flows downstream to the Carmel River Lagoon area and river mouth, increasing the frequency and severity of

downstream flooding. Sediments that would normally be deposited when flood flows move laterally into floodplains are now carried downstream and contribute to the buildup of a natural flow barrier at the river mouth. The flow barrier causes the northward migration of the river mouth. These conditions increased water levels several feet in the adjacent lagoon and increased erosion of adjacent scenic coastal roadways (Scenic Road) during flood events. Sandbar management activities historically partially mitigated impacts to low-lying structures and public infrastructure. However, these activities have been found to cause loss of aquatic habitat in the lagoon area.

Past flooding events have caused expensive and severe damage to the areas around the lower reach of the Carmel River. The most noted events include the March 1995 flood and February 1998 flood. The 1995 flood, considered a 20- to 30-year flood event, destroyed the Highway 1 Bridge and flooded development on both sides of the highway. During the 1995 and 1998 events, sewage treatment was disrupted in the lower Carmel River residential and commercial areas. A state of emergency was declared during both of these events.

The lower reaches of the river and lagoon areas are rated as the highest on the list of repetitive loss areas in Monterey County, coupled with damage to coastal scenic roadways from associated channel erosion. Furthermore, portions of the project area lie inside the county's tsunami wave run-up boundary and are subject to moderate tsunami hazards. Projected rising sea levels resulting from global climate change could further exacerbate this flooding problem.

Highway 1 Bridge over the Carmel River during the March 1995 Flood
Source: Monterey Peninsula Water Management District

Flood Hazard Type(s)

Type(s): Failure of Engineered Structures, Coastal Flooding, Tsunami Flooding

Solution

Several interrelated projects have been proposed to improve hydrologic functions, restore habitat, and reduce flooding hazards along the lower Carmel River. These projects are multiple objective and provide opportunities for other benefits, including water quality, water supply, cultural practices, and recreation. The integration of management actions forms the basis for specific projects being planned and implemented. Some examples of key management actions include:

- Increasing accuracy and completeness of map information through topographic surveys to clearly define elevations pertinent to flood control planning
- Conducting geotechnical engineering analysis and hydraulic modeling needed to support design of flood control improvements
- Modifying placement and/or size of existing levees and/or floodwalls, and adding new levees or floodwalls to improve flood protection
- Improving hydrologic functions by reconnecting floodplains through land restoration. This is accomplished with actions such as regrading lands, modifying or removing nonstructural levees, re-vegetating with native species, and reestablishing riparian and wetland habitat in the floodplain and off-channel wetland habitat
- Integrating storage and filtration basins into restored floodplains to increase flood flow retention, promote sediment and nutrient removal, and increase groundwater recharge
- Establishing and preserving agricultural operations adjacent to, but hydrologically disconnected from, the floodplains

Provided below is a summary of the interrelated projects. The relative location of these projects is shown in the accompanying map placed at the end of this section.

O'dello East Area: Projects for this area, which is south of CSA-50, will enhance native riparian and wetland habitat while restoring hydrologic function. This will be accomplished through the following projects:

- Big Sur Land Trust Floodplain Restoration Project. This project is in the design phase and involves floodplain restoration efforts to reshape lands to create the hydrologic characteristics necessary to support natural hydrologic processes and ecosystem functions. This includes modifications of nonstructural earthen levees

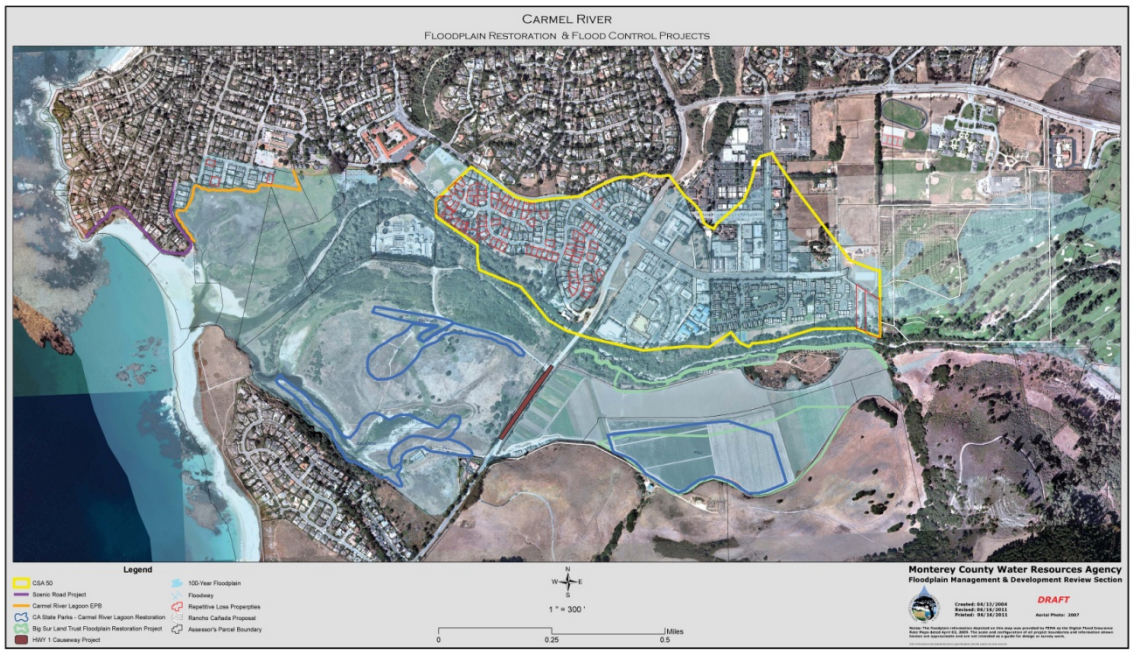
and adjustment of topography to direct flood flows to restored floodplains, and introduction of various habitat types, including shallow seasonal habitat areas along the river and within the floodplain.

- Highway 1 Causeway Project. This project is in the design phase and consists of constructing a causeway to facilitate conveyance of flood flows under Highway 1. This would reconnect the floodplain area east of the highway (O'dello East Area) with the floodplain and lagoon west of the highway (Carmel River Lagoon Area). The causeway will also address existing deficiencies with this segment of the highway and reduce flood hazards to the route.

Carmel River Lagoon Area: In recent years, fish and wildlife habitat improvements have been made in the Carmel River Lagoon area. Flood flow conveyance and floodplain connectivity improvements are proposed between this area and the adjacent upstream floodplain area east of Highway 1 (O'dello East Area). This improved hydrologic function would increase the flood flow capacity and enhance floodplain habitat conditions. Completed and additional planned improvements include:

- California Department of Parks and Recreation (California State Parks) – Carmel River Lagoon Restoration. This completed project expanded the lagoon by restoring adjacent agricultural lands. The project included excavation of a remnant southern arm of the lagoon on the western side of Highway 1 to expand aquatic habitat for steelhead and riparian wildlife.
- Carmel River Lagoon Ecosystem Protective Barrier (EPB) Project and Scenic Road Preservation and Protection Project. These two projects are in the planning stages and will protect adjacent low-lying residential structures, adjacent park facilities, and Scenic Road. They will also provide habitat for fish and wildlife and reduce or eliminate sandbar management activities.

CSA-50: Originally completed in 2002, an updated flood control project report is planned for CSA-50. This effort is in the planning stages and specific actions have not been identified. When the report update is completed, the preferred project will identify specific actions that address flood control needs, and that further enhance hydrologic connectivity with the O'dello East area (south of CSA-50) and improve water quality of stormwater runoff from CSA-50. Following completion of this updated report, the next phase of work will involve completing environmental documentation and permitting necessary to implement the preferred project, and also recommendations from the Carmel River Lagoon EPB and Scenic Road Preservation and Protection Project feasibility analyses (discussed above).



Project Components

Source: Monterey County Water Resources Agency

Success Factors:

Many factors have contributed, and continue to contribute, to the success of ongoing and planned efforts related to the Carmel River Project. Through creative partnerships, solutions associated with and planned for this project are being developed in coordination with other ongoing but related efforts in the area, increasing the opportunity for multiple benefits. For example, BSLT, one of the Carmel River Project responsible agencies, is also working on creating an extensive network of open space and trails along the lower Carmel River. This has been made possible through teaming with agencies that are partners in and supporters of this project.

Integrated Management Actions

The Carmel River Project encompasses structural and nonstructural actions integrated to achieve multiple benefits. Primary actions are summarized below:

- Set back or remove levees to connect rivers to floodplains
- Restore lands to a more naturally functioning floodplain
- Restore channel form and function to improve operation and maintenance and facilitate flood damage reduction
- Construct new bypasses to improve flood system performance
- Construct new levees or floodwalls to provide flood protection to additional areas potentially affected by flooding
- Improve structural performance and resilience of existing flood facilities
- Develop local flood management plan updates

Integrated Benefits

The Carmel River Project proposes to restore and enhance the lowest reach of the Carmel River to increase native habitats and provide flood reduction benefits to areas prone to flood hazards.

Flood protection benefits include the following:

- Reducing damages to residences, commercial businesses, and local and State of California infrastructure
- Improving connectivity between the main channel and overbank areas to reduce flooding hazards
- Providing a protective buffer against sea level changes

Ecosystem benefits include the following:

- Recovering natural functions and values that were present historically
- Restoring riparian and wetland habitat within the historical floodplain
- Increasing habitat connectivity between the main channel, floodplain habitat, and lagoon habitat

Other benefits include the following:

- Increasing recharge and storage of groundwater
- Improving the quality of water entering the Carmel River lagoon
- Maintaining historically important agricultural operations
- Improving recreation and associated public access

Financial Information and Project Status

O'dello East Area: Currently, BSLT has secured approximately $17 million in grant funding necessary for project implementation, and they continue to pursue additional grant funding for contingencies, including the State's Integrated Regional Water Management Grant Program. Additional grant funding, however, is not currently available for the Highway 1 Causeway Project. California Department of Water Resources (DWR) recently published draft funding recommendations for the Flood Protection Corridor Program 2010-2011 Competitive Grant funding. BSLT requested $5 million in grant funds, which would help provide partial funding for the Highway 1 Causeway Project.

Carmel River Lagoon Area: The California State Parks implemented the Carmel River Lagoon Enhancement Project to expand the lagoon west of Highway 1. The Conservancy funded $4 million to the California State Parks to lead this effort. The MCWRA received a $145,000 Wildlife Conservation Board grant to complete a feasibility analysis for the Carmel River Lagoon EPB Project, and the MCDPW received a $54,200 DWR grant to complete a feasibility analysis for the Scenic Road Protection and Preservation Project. These feasibility analyses will identify a preferred project for each area.

CSA-50: MCWRA received a $500,000 EPA special appropriation for the lower Carmel River. A work plan is currently being developed to utilize the funds. Phase I of the draft work plan is focused on developing a preferred project within CSA-50. Phase II is anticipated to involve completing environmental documentation and permitting necessary to implement recommendations of the Phase I report, and also recommendations from the Carmel River Lagoon EPB and Scenic Road Preservation and Protection Project feasibility analyses.

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Big Sur Land Trust. *Lower Carmel River and Lagoon Floodplain Restoration and Enhancement Project Fact Sheet.* January 2008.

Big Sur Land Trust and Monterey County Water Resources Association. *Draft Initial Study for the Big Sur Land Trust Carmel River Floodplain Restoration and Environmental Enhancement Project.* February 2011.

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Monterey County Resource Management Agency. "Carmel River Floodplain Restoration – Board Approves Grant Application." *RMA News*, Volume 5, Issue 4. April 2012.

Monterey County Water Resources Agency. *Monterey County Floodplain Management Plan Update.* 2008.

Monterey County Water Resources Agency. *Draft Work Plan - Lower Carmel River Floodplain Restoration and Flood Control Project (R9 06-211 2011 Special Appropriation).* March 2012.

Monterey Peninsula Water Management District. *Monterey Peninsula, Carmel Bay, and South Monterey Bay Integrated Regional Water Management Plan.* November 2007.

Project Name: San Bernardino County Flood Control District Groundwater Recharge Program – Cactus Basins 3, 4, and 5

Responsible Agency	San Bernardino County Flood Control District
Partners	San Bernardino Valley Municipal Water District City of Rialto Public Works Department California Department of Water Resources
Region/County	South Coast/San Bernardino County

Project Area

The project is situated in a developed, highly urbanized area in the north-central portion of the City of Rialto. The project site is an undeveloped field owned by San Bernardino County that is approximately 140 acres in size. The Cactus Basins (Basins 3, 4, and 5) are unlined retention basins located between U.S. Highway 210 and Baseline Road, west of Cactus Avenue, and east of Ayala Drive.

The project site is primarily a gently sloping (less than 2 percent) alluvial fan. Several small shallow drainage channels cross the site, and a significant portion of the land is being used for gravel pit operations. Cactus Basins 3, 4, and 5 are a part of the Rialto Channel system. Cactus Basin 3 has acted as a flood management facility from the time it was used as a borrow pit in 1976.

Problems and Need

Flooding along the Rialto Channel (located immediately downstream from the Cactus Basin channels) occurs on a regular basis. Even during moderate storms, flooded roadways adjacent to the Rialto Channel become a public hazard for both pedestrian and vehicular traffic. During these moderate events, the City of Rialto has to expend resources to both manage the flooding for public safety during the event, and to clean up afterwards. In the winter 2004/2005, severe flooding along the channel damaged several property walls of residences immediately adjacent to the channel. The cost to replace the block walls was approximately $1.2 million, which was shared by both the San Bernardino County Flood Control District and the City of Rialto. Estimated 50-year and 100-year flood damages under without-project conditions are approximately $27.3 and $30.5 million, respectively.

Inadequate water supply: Planned development in the City of Rialto will increase the amount of impervious area, which will increase both the magnitude of peak flows and the volume of storm runoff. Also, additional development will interrupt natural groundwater recharge processes and increase water usage.

Flood Hazard Type

Types: Alluvial Flooding. Flash Flooding. Debris Flow Flooding.

Solution

The project includes enlargement of three existing unlined retention basins and construction of a habitat restoration area. The main objective of the proposed project is to eliminate any potential increase in flood hazard due to extensive development in the northern portion of the watershed. Cactus Basins 3, 4, and 5 are essential to adequately protect the City of Rialto's primary commercial/industrial area. The project is intended to attenuate upstream flows for stormwater facilities located downstream from the project area, thereby allowing the regional flood management system to function more efficiently. Once the Cactus Basins are completed, they will provide 100-year flood protection for residents and businesses within the Rialto Storm Drain system by reducing peak flows. Under current conditions, Cactus Basins 3, 4, and 5 have a total capacity of 447 acre-feet and 100-year storm peak outflows of 8,215 cubic feet per second. Cactus Basin 3 is currently the only functioning basin. Once the proposed improvements are constructed, total capacity will increase nearly five times, to approximately 2,039 acre-feet. Peak flows will thus be reduced to 1,244 cubic feet per second. The 80 percent reduction in peak outflow will provide flood protection to the immediate vicinity and allow downstream facilities to be designed with smaller capacities.

The proposed project will entail grading the three unlined retention basins and constructing a system of basin inlets and outlets to route storm runoff in a controlled manner. The three existing basins will be excavated (following previous sand and gravel removal activities) to increase the depths to permit storage of increased stormwater runoff. Slopes will measure between 20 feet and 46 feet in height from the bottom of the basins to the top of the slope. The inlets to Basins 3, 4 and 5 will be constructed using concrete and a half-ton of ungrouted rock. Width will range between 210 feet and 300 feet. The rock used at the inlets will reach from the top of the embankment to the toe at the basin bottom, and will include a 25-foot-wide splash pad. Surface water in the area will flow southward from Basin 5 to Basin 4 and from Basin 4 to Basin 3. Surface water will then flow from Basin 3 through an existing reinforced concrete box and pipe structure (located in the southwest corner of Basin 3) under Baseline Road into the Rialto Channel and the existing Basins 2 and 1. The outlet of existing Basin 1 connects to Rialto Channel, which flows approximately 5.4 miles southward to the Santa Ana River.

Water that exceeds the capacity of the culvert will overtop and use the emergency spillway from Basin 5 to Basin 4. The spillway will be constructed of reinforced concrete, 120 feet wide with a quarter ton of rocks added to the sides and concrete for protection. The outlet of Basins 3 through 5 will all incorporate a reinforced concrete box culvert.

The project can logically be subdivided into three main aspects:

Construction of basins

Operation of the facility for flood management purposes

Operation of the facility for artificial recharge of retained stormwater runoff

The project's primary function will be to enhance flood protection, and it will increase the local water supply by acting as a groundwater recharge facility. In their current condition, Cactus Basins 3, 4, and 5 do not have groundwater recharge capabilities. Total annual recharge capacity for the improved Cactus Basins 3, 4 and 5 was estimated in the 1988 Environmental Impact Report to be 35,000 acre-feet per year, with an average of 15,000 acre-feet per year. The percolation rate of the basins was determined in the Santa Ana River Water Rights Application for Supplemental Water Supply. Because of the project's groundwater recharge potential, local water purveyors will be able to use the facility to increase their water supply and incorporate that increase into their water management programs.

Portions of the basins will be used for ecosystem restoration as part of environmental permitting requirements. San Bernardino County Flood Control District will hydroseed the project site with an alluvial fan sage scrub seed mix. A 2.67-acre area immediately east of Basin 3 will be reserved as a riparian habitat revegetation area in which cuttings will be installed and seeded over in accordance with the Cactus Basin 3 revegetation plan. The loss of alluvial fan sage scrub will be mitigated offsite by preserving 45 acres of reserve mitigation land within the Santa Ana River basin in perpetuity. Potential mitigation sites include Lytle Creek, San Sevaine Creek, and Cucamonga Creek.

Success Factors:

The project and affected watershed are located within the City of Rialto. The city has a relatively large population of low- to moderate-income families, as defined by thresholds developed under the U.S. Department of Housing and Urban Development Community Development Block Grant Program. This population has been historically underserved in infrastructure and public works improvements. The project will provide improvements to the community in flood risk reduction, water supply, and habitat restoration from previous gravel pit operations.

Integrated Management Actions

Main actions implemented for Cactus Basins 3, 4, and 5 include the following:

- Increase on-stream flood storage capacity by building new storage facilities or updating, modifying, or replacing existing flood storage facilities.
- Improve conveyance by addressing flow constrictions.
- Improve water supply by using flood basins for groundwater recharge.
- Improve the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.

Integrated Benefits

The proposed improvements will provide multiple benefits to the communities in the watershed, such as flood management, an increased water supply through groundwater recharge, and ecosystem restoration.

Financial Information and Project Status

In 2011, various technical studies have been performed regarding hydrology and hydraulics related to this project and Rialto Channel downstream from the basins. The required environmental documents (CEQA) were prepared and approved by the City of Rialto in 1988. Because of the time lapse since approval of the original document and the need to comply with current standards, the district completed a CEQA document for the Supplemental Environmental Impact Report in December 2008 for Cactus Basin 3. CEQA documentation for Cactus Basins 4 and 5 will be completed before construction. Design is approximately 98 percent complete for Cactus Basin 3 and 30 percent complete for Cactus Basins 4 and 5. For Cactus Basin 3, plans are in the final stages of review and environmental clearance. Construction of the entire project is expected in 2015.

Total project cost is expected to be approximately $35,346,985. The project was awarded $1,000,000 in Proposition 84 Stormwater Grant funds from the California DWR through the Santa Ana Watershed Project Authority.

Primary Information Sources

San Bernardino County. 2011 Federal Legislative Platform. 2011.

San Bernardino County Flood Control District. Proposition 1E Stormwater Flood Management Application. October 3, 2011.

Santa Ana Watershed Project Authority. *One Water One Watershed Project Information, Cactus Basins 3 and 3A, Project Number 1190*. 2010.

Santa Ana Watershed Project Authority. *One Water One Watershed Project Information, Cactus Basins 4 and 5, Project Number 1180*. 2010.

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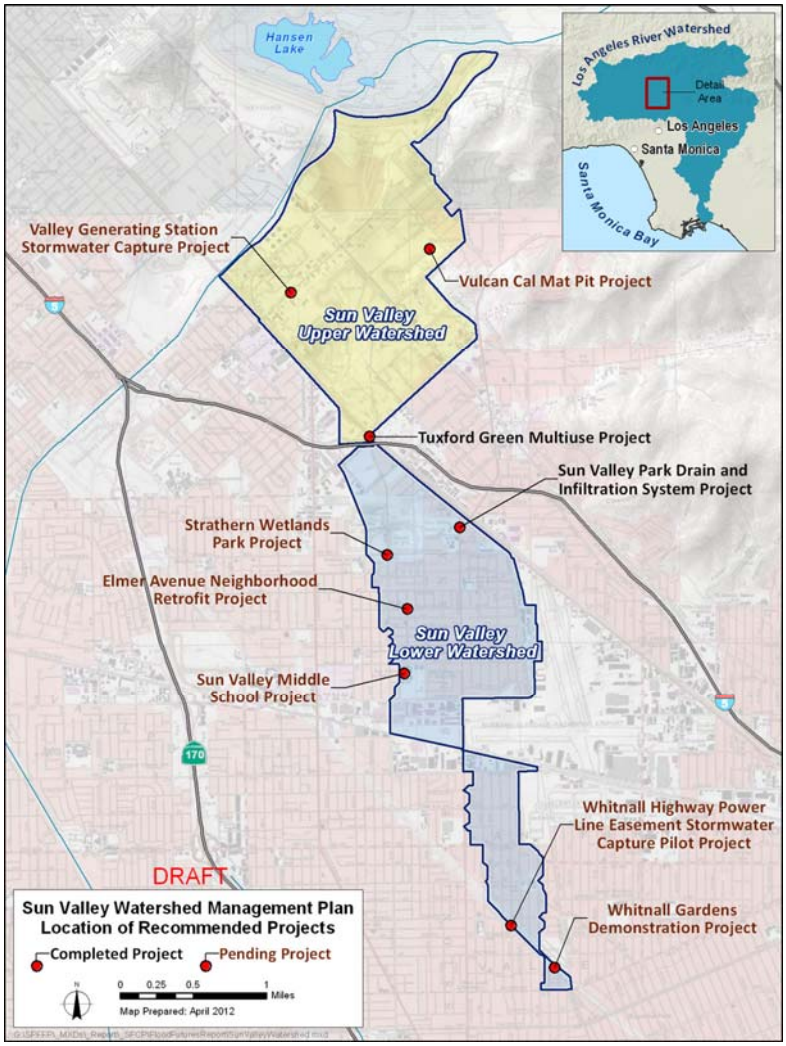
Project Name: Sun Valley Watershed Management Plan

Responsible Agency	Los Angeles County Department of Public Works (LACDPW)
Partners	The Sun Valley Watershed Management Plan (Watershed Management Plan) is an integrated watershed management effort focused on solving chronic stormwater flooding within a subwatershed of the Los Angeles River. The Watershed Management Plan is directed by the LACDPW, with extensive input from the Sun Valley Watershed Stakeholders Group (Stakeholder Group). Organizations involved in the diverse stakeholder group include 20 city agencies, 3 county agencies, 12 State agencies, and 10 environmental agencies. Other key stakeholders include the U.S. Department of the Interior, Southern California Association of Governments, Los Angeles Trails Project, Los Angeles Unified School District, Upper Los Angeles River Area Watermaster Services, and dozens of local businesses, industries, and area residents.
Region/County	South Coast/Los Angeles County

Project Area

The Sun Valley watershed is located in the San Fernando Valley in the city of Los Angeles, approximately 14 miles northwest of downtown Los Angeles. The watershed is a 2,800-acre (4.4-square mile) sub-basin of the Los Angeles River watershed. It is densely urbanized with approximately 60 percent of the area dedicated to industrial and commercial use.

The Watershed Management Plan project area is coincident with the Sun Valley watershed shown on the accompanying map. Also shown on the map are projects recommended by the plan. The plan and associated projects are discussed in the Solutions section below.



Problems and Need

The Sun Valley watershed has experienced numerous flooding and related problems during the last 40 years. The most significant issues include flood damage, water quality, and habitat degradation.

Limited Flood Management Facilities: As in most heavily urbanized area, about two-thirds of the ground in Sun Valley is covered by hard or impervious surfaces. Underground storm drain systems are used to carry stormwater away from urbanized areas. However, the Sun Valley watershed is not served by a comprehensive underground storm drain system; instead, stormwater is primarily conveyed on street surfaces with relatively flat slopes. As a result, light rainfall leads to moderate to severe flooding of city streets.

Another problem is the location of existing flood management structures. Flood management structures that convey stormwater from the Sun Valley watershed to the Los Angeles River are located on the southern end of the watershed and are too far from the northern part of the watershed to provide flood management for that area. As a result, the runoff from the upper watershed discharges directly onto city streets into the lower, southern end of the watershed.

Chronic Street Flooding – Sun Valley Watershed *(Source: LACDPW, 1989)*

Water Quality and Ecosystem Impacts: Development of the Sun Valley watershed has resulted in significant water quality impacts to the Los Angeles River, and has reduced and fragmented native habitat. Development has decreased vegetation and open space, which has reduced the natural retention of rainfall and has impacted the productivity and diversity of wildlife in the watershed. Approximately 66 percent of rainfall within the watershed flows untreated to the Los Angeles River. Runoff from the watershed often includes elevated contaminants typical of urban stormwater, such as nitrogen, ammonia, pH, algae, scum, odors, coliform, trash, and heavy metals (SWRCB, 2003). Heavy metals are noticeably higher in flows originating in the lower watershed because of the higher concentration of industrial and automotive land uses in this area.

Flood Hazard Type

Types: Local Stormwater Flooding and Debris-Flow Flooding

Flooding is primarily caused by urban development and inadequate flood management facilities. Uncontrolled runoff flows through developed areas within the watershed, hindering transportation, damaging property, and carrying debris and contaminants into the downstream Los Angeles River.

Solution

Numerous projects have been proposed to relieve flooding in the Sun Valley watershed. A traditional, single-purpose regional relief drain was proposed in 1989 but was never implemented. During the 1990s, Sun Valley stakeholders and the LACDPW began to explore an innovative, integrated approach to solving flooding and related problems using more sustainable practices. These efforts resulted in the Watershed Management Plan, which was completed by the stakeholders and adopted by the Los Angeles County Board of Supervisors in 2004. The primary objective of the Watershed Management Plan is to reduce existing and future flooding to levels consistent with LACDPW standards, using a wide range of multiple objective projects that collectively also increase water conservation, increase recreational opportunities, increase wildlife habitat, improve water quality, provide additional environmental benefit, and increase multiple agency participation. Extensive stakeholder input helped identify potential projects based on their ability to meet these objectives in a cost-effective manner. As a group, the planned projects are designed to control runoff from a 50-year frequency design storm, a LACDPW stormwater management standard.

Specific management actions supported by the Watershed Management Plan include retention basins, underground storage, infiltration basins, and large-scale stormwater separation devices to remove trash and suspended pollutants. These are integrated with actions to increase open space and connect fragmented habitats through restoration of commercial and industrial gravel pits, improvements along easements and rights-of-way utility corridors, incorporation of trails along these corridors, and improvement of public access to

restored areas. The integration of various combinations of these, and other similar management actions form the basis for the projects recommended by the Watershed Management Plan. These recommended projects are summarized below.

Sun Valley Park Drain and Infiltration System Project: Completed in 2006, this project converted an existing municipal park into a multiple use site incorporating stormwater management, water quality treatment, and water conservation. The project alleviates localized flooding through a new storm drain. The storm drain routes runoff through a water quality treatment system to remove suspended solids and heavy metals. Treated runoff is then routed to infiltration basins to recharge groundwater. Because the system is underground, the park's recreational elements are undisturbed. The project also includes the addition of new soccer and baseball fields, refurbished recreational amenities, and vegetative swales that both improve natural beauty and treat runoff.

Tuxford Green Multiple Use Project: Completed in 2007, this multiple objective project uses a series of catch basins and storm drains to collect runoff from a 2.2-square-mile urbanized area. Stormwater is treated and conveyed under an existing intersection and hydraulic pressure "pushes" flows up to an existing culvert, where they continue to the southern end of the watershed. The project includes landscaping of a previously barren corner of the intersection with native plants that are irrigated with stormwater stored in a 45,000-gallon underground cistern.

Strathern Wetlands Park Project: This project will convert a 46-acre, engineered, inert landfill into a multiple purpose wetlands park. A storm drain system, detention ponds, and wetlands will be constructed to capture and treat stormwater runoff. Treated flows will be pumped to the adjacent Sun Valley Park groundwater infiltration basins providing recharge into the local groundwater system. In addition to water quality improvements, the constructed wetlands will also enhance native vegetation, and create opportunities for wildlife habitat and recreation.

Valley Generating Station Stormwater Capture Project: The Valley Generating Station is a power-generating facility owned and operated by Los Angeles Department of Water and Power (LADWP) and located within the upper Sun Valley watershed. For this project, stormwater runoff from the area will be captured, treated, and directed through a series of recharge basins, swales, and overflow culverts. The project may also consider upgrades to the existing gravel pit for use as possible storage and stormwater infiltration and construction of a large infiltration swale to provide offsite stormwater capture.

Whitnall Gardens Demonstration Project: This project will feature a conservation garden, including drought-tolerant planting, a walking path, and stormwater capture. A storm drain system will direct stormwater runoff into a 32,000-cubic-foot infiltration basin. This small-scale demonstration project is intended to inform the development of other San Fernando Valley projects that share similar soil characteristics. An infiltration test was conducted at this site in March 2009, which proved the soils in this area to be excellent for infiltration at a rate of 8.2 feet per day.

Elmer Avenue Neighborhood Retrofit Project: This project was led by the Council for Watershed Health and TreePeople and was completed in 2010. Project features capture and treat runoff from 40 acres of residential land-use, provide 16 acre-feet of groundwater recharge annually, and reduce peak flows and pollutant loads to the Los Angeles River.

Other Planned Projects: Other potential projects included in the Watershed Management Plan are in the early stages of discussion and, because they are associated with private land holdings, may be several years away from implementation. These projects include:

- Vulcan Cal Mat Pit Project
- Whitnall Highway Power Line Easement Stormwater Capture Pilot Project
- Sun Valley Middle School Project

The Vulcan Cal Mat Pit Project would place a berm around an existing landfill that currently stores inert debris to create a retention basin that would store and promote infiltration of runoff from adjacent residential areas. The Whitnall Highway Power Line Easement Stormwater Capture Pilot Project would capture stormwater runoff at several locations along the easement and direct stormwater into a network of swales, culverts, hydrodynamic separators, and infiltration basins for pretreatment and infiltration. The Sun Valley Middle School Project would incorporate a new storm drain to collect runoff and alleviate flooding from adjacent residential areas, an underground infiltration basin, and bioswales for groundwater recharge. The project will also be featured as part of an environmental education program.

Success Factors:

The projects for the Sun Valley watershed have required a high degree of collaboration among multiple stakeholders, including government officials, civic organizations, local businesses, and area residents. LACDPW hosts a quarterly meeting with a Sun Valley Watershed Stakeholder Group, which provides a key venue to receive stakeholder input, inform stakeholders of watershed issues, and update stakeholders on the status of ongoing projects.

Interagency cooperation has been critical to the success of the Watershed Management Plan. Using the integrated water resources approach promotes creativity in project design and encourages participation from

multiple agencies in the watershed. All parties are encouraged to recognize the legitimacy of each other's organizational goals and seek to maximize all the goals of all parties as much as possible. This helps each agency accomplish their own organizational goals cooperatively while also making the best use of human and financial resources in implementing the Watershed Management Plan.

Integrated Management Actions

The main actions implemented for the Watershed Management Plan projects include the following:

- Construct debris basins (use of large-scale stormwater separation devices to remove trash and suspended pollutants).
- Improve interior drainage (use of storm drain systems).
- Manage runoff through watershed management (increased vegetative cover, infiltration basins, minimizing impermeable surfaces).
- Improve the quality, quantity, and connectivity of wetland, riparian, woodland, grassland, and other native habitat communities.
- Manage municipal stormwater to provide regional or system-wide flood benefits.
- Increase local agency awareness of flood mitigation compliance and grant application assistance (through the Stakeholder Group).
- Improve awareness of floodplain function through outreach and education (through the Stakeholder Group).
- Encourage multi-jurisdictional and regional partnerships on flood planning and improve agency coordination on flood management activities, including operation and maintenance, repair, and restoration (through the Stakeholder Group).

Integrated Benefits

Projects to address stormwater issues in the Sun Valley watershed will provide multiple benefits to water supply, recreation, wildlife habitat, and water quality. Specific integrated benefits of the projects are discussed below.

- Increase Water Supply: Increase local water supplies by capturing runoff and recharging groundwater. Use captured runoff for non-potable purposes to reduce the demand for potable water.
- Increase Recreational Opportunities: Increase recreational opportunities in the watershed by increasing the acreage of parks and the number of sports fields, adding equestrian and bike trails, and increasing public access.
- Increase Wildlife Habitat: Improve wildlife conditions by restoring and connecting existing flood easement and right-of-way corridors within the Sun Valley watershed.
- Improve Water Quality: Improve the water quality of the Los Angeles River by removing the pollutant load generated from stormwater in the Sun Valley watershed.
- Provide Additional Environmental Benefit: Provide additional environmental benefits as a result of implementing management actions that help reduce flooding or accomplish other objectives described above. For example, tree planting may help reduce urban runoff and provide shade to buildings, resulting in reduced energy costs for air-conditioning. Trees also cleanse air, thereby improving air quality.
- Increase Multiple Agency Participation: Increase multiple agency participation in local flooding and related water resource management challenges. Benefits of this include, but are not limited to, additional funding sources; a more involved government and community; increased literacy and awareness on watershed, water supply, and water quality issues; more effective use of resources; and increased opportunities to improve the economic climate for Sun Valley residents.

Financial Information and Project Status

Watershed Management Plan projects are being implemented in phases, and are in various stages of securing funding. Project status, cost, and funding are described below:

Sun Valley Park Drain and Infiltration System Project: This project was completed in 2006 with a total project cost of approximately $7 million. The project was funded by a California Department of Water Resources (DWR) (Local Groundwater Assistance) grant, a Proposition 12 (Murray-Hayden) grant received by TreePeople, and the Los Angeles County Flood Control District.

Tuxford Green Multiuse Project: This project was completed in 2007 with a total project cost of approximately $3.7 million. The project was funded by the Los Angeles County Flood Control District.

Strathern Wetlands Park Project: This project is currently in the design phase and construction is scheduled for the fall of 2013. The total cost for design and construction is estimated at $50 million and will be funded by the Los Angeles County Flood Control District, the LADWP, and Proposition O grant funds.

Valley Generating Station Stormwater Capture Project: This project is currently in the planning and design phase. There is no specific schedule for project design and construction. The estimated construction cost is $9.7 million.

Whitnall Gardens Demonstration Project: This project is currently in the design phase. There is no specific schedule for project construction. The estimated construction cost is $1.3 million.

Whitnall Highway Power Line Easement Stormwater Capture Pilot Project: This project is currently in the planning and design phase. Design is expected to be completed the end of the 2014 fiscal year, followed by construction, which is to be completed by 2015. The land is already secured and the estimated construction cost is $7.3 million.

Elmer Avenue Neighborhood Retrofit Project: This project was completed in 2010 with a total project cost of approximately $2.7 million. This cost covered all project stages, including monitoring, data gathering, design, construction, and outreach. This project was funded by the U.S. Department of the Interior, Bureau of Reclamation; DWR; LACDPW; Metropolitan Water District of Southern California; Water Replenishment District of Southern California; LADWP; and the City of Santa Monica.

Cost estimates have not been developed for the Vulcan Cal Mat Pit Project or the Sun Valley Middle School Project.

By filing grant applications, the Stakeholder Group has been able to help contribute to financing the above projects.

A U.S. Army Corps of Engineers feasibility study is also currently being completed to determine whether there is a Federal interest in the Water Management Plan projects.

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Los Angeles County Department of Public Works. *Sun Valley Watershed Management Plan – Overview Fact Sheet.* October 2011.

Los Angeles County Department of Public Works. *Sun Valley Watershed Management Plan – Strathern Wetlands Park Fact Sheet.* March 2012.

Los Angeles County Department of Public Works. *Sun Valley Watershed Management Plan – Sun Valley Park Drain and Infiltration System Fact Sheet.* March 2012.

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Los Angeles County Department of Public Works. *Sun Valley Watershed Management Plan – Valley Generating Station Stormwater Capture Project Fact Sheet.* November 2011.

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Los Angeles County Department of Public Works. *Sun Valley Watershed Management Plan – Whitnall Highway Power Line Easement Stormwater Capture Pilot Project Fact Sheet.* January 2012.

State Water Resources Control Board (SWRCB). *2002 CWA Section 303(d) List of Water Quality Limited Segments, Draft Version.* January 13, 2003.

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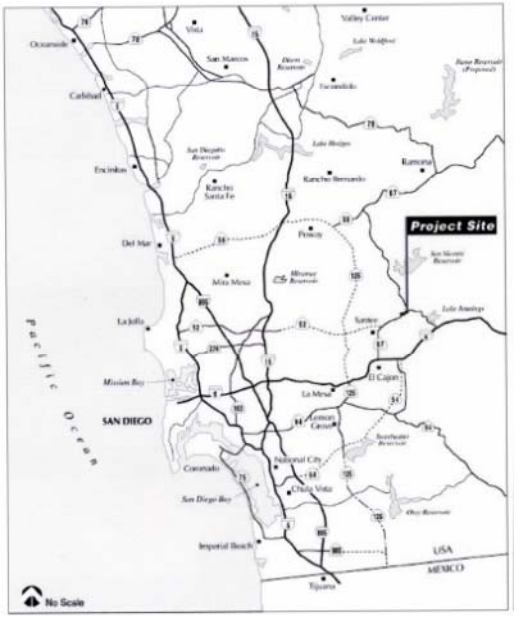
Project Name: Flood Management, Habitat Restoration and Recharge on the San Diego River

Responsible Agency	Lakeside's River Park Conservancy (LRPC)
Partners	The Lakeside's River Park Conservancy's project, Flood management, Habitat, Restoration and Recharge San Diego River (LRPC Project), was developed through collaboration among multiple agencies, including: • San Diego River Park Foundation • Wildlife Conservation Board • San Diego River Conservancy • Riverview Water District • California State Coastal Conservancy (Conservancy) • California State Water Resources Control Board (SWRCB) • California Department of Transportation (Caltrans) • The Resources Agency
Region/County	South Coast/San Diego County

Project Area

The project is located in the community of Lakeside in San Diego County and is within a 580-acre area known as the Upper San Diego River Improvement Project (USDRIP). The area surrounding USDRIP is urban in nature, with industrial, commercial, and residential uses. USDRIP was established in the 1980s for the purpose of channeling the San Diego River to prevent future floods following two disastrous floods during the winters of 1978-79 and 1981-82.

Incorporated in 2001, LRPC's main area of concern is the Lakeside community located along a 2.5-mile stretch of the San Diego River. The project area is located along the northeastern edge of San Diego's urbanized zone, approximately 21 miles northeast of downtown San Diego (see figure). Lakeside is surrounded by a rural setting. As the population of this community steadily grew during the mid- to late 20th century, the community faced various challenges, including flood hazards and environmental degradation. This segment of the San Diego River valley is now within a rapidly growing part of San Diego County. Improvements to the San Diego River and adjacent lands continue to be discussed, with continued emphasis on flood management, environmental habitat restoration, recreation, and water supply.



Source: *Upper San Diego River Improvement Project Environmental Impact Report,* August 2000, County of San Diego

Problems and Need

Flooding has created numerous problems for Lakeside, including the loss of roads and bridges that linked the northern and southern halves of the community and the rupture of sewer lines that crossed the river. The western half of USDRIP, including the project site, has been dominated by sand mining since the 1930s. Two sand mining ponds existed on the project site. The ponds created deep, open water in the river channel that acts as a sediment trap during a flood. This causes a buildup of sediment in the channel, decreasing the channel's capacity to convey floodwaters. Flooding was further aggravated by a constriction in the river north of the project site, thereby causing floodwaters to move at a much faster rate than would have been with a wider floodway.

Source: *Lakeside's River Conservation District.* Photograph courtesy of Peter Nelson.

Lakeside experienced catastrophic damages from floods in the 1978-79 and 1980-81 flood seasons. The flooding damaged homes, transportation corridors, commercial and public facilities, and pipelines. These two flood events were the first floods to occur since the community began its transformation from a rural, farming community to a suburban bedroom community. Until recent flood management improvements were completed, damaging flood events of this type were expected to occur about every 17 years.

The County of San Diego responded to flooding in the Lakeside area with an ambitious plan to reduce flooding by sand mining the alluvium from the river, reclaiming and raising riverbanks with imported fill, and creating a channelized floodway. Although this process had some success in reducing flooding during 10-year events (3,500 cubic feet per second), it has never been tested in a flood event anywhere near the anticipated 100-year flood flows (35,000 cubic feet per second).

Loss of habitat, recharge, and recreation: Many of the natural functions of the river, including habitat, water quality, and recharge, have been lost in the process of channelizing portions of the river. The river has also lost its place as a source of recreation in the community. Up until recently, the sand mining operations along the river limited the public from accessing and enjoying walking, biking, or riding along the river for many years.

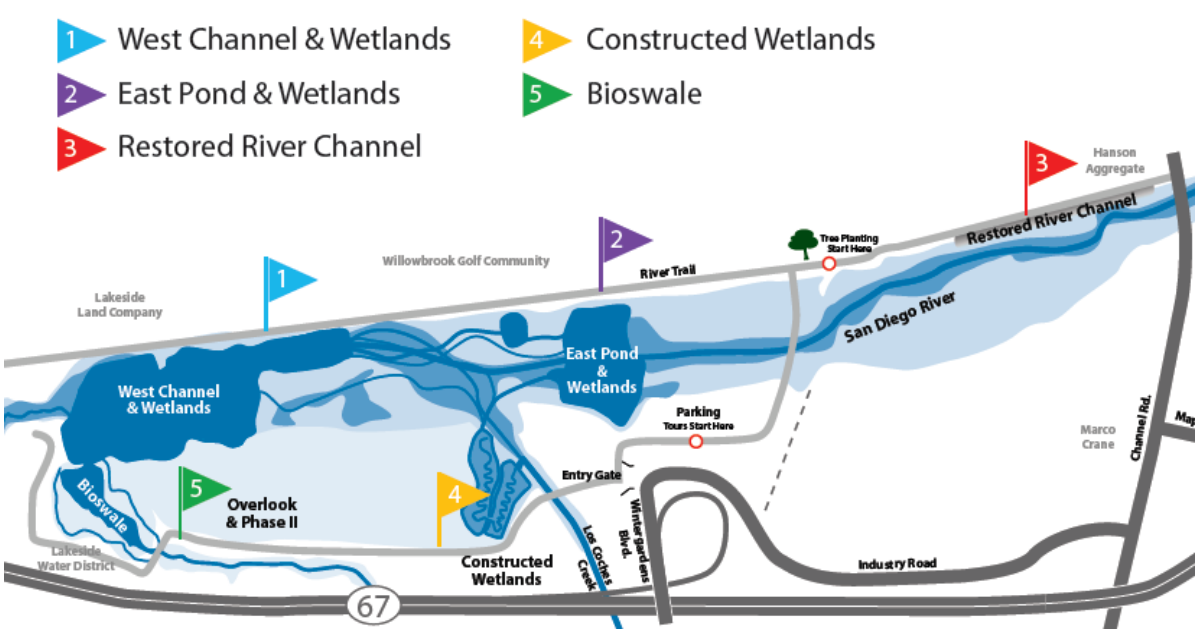
Flood Hazard Type

Type(s): Slow Rise Flood

Solution

The focus of this project is the restoration of the natural functions of the San Diego River corridor. The 100-acre area was formerly a sand and gravel mine. This project was approached in two phases.

Phase I consisted of five major elements: (1) West Channel and Wetlands, (2) East Pond and Wetland, (3) Restored River Channel, (4) Constructed Wetlands, and (5) Bioswale. These elements performed specific functions in the manner described below.



Source: *Flood Control, Habitat, Restoration, and Recharge on the San Diego River, Final Report,* Lakeside's River Park Conservancy, April 28, 2010.

1. Improving filtration and circulation: The West Channel and Wetlands were originally excavated as a sand and gravel mining pond. The restoration focus here was to increase the wetlands, improve circulation in the pond, and improve sediment transport. The pond was made shallower with fill to create a defined channel and to improve circulation. To achieve this, a subterranean concrete wall was constructed along the southern edge of the pond and fill was placed behind it. A new wetland was formed south of the fill area through which water circulates. Coast live oak and sycamore were introduced, along with cottonwood and willow. This wetland vegetation cleans the water of pollution and supports nesting and spawning.
2. Flood management and water quality: The East Pond and Wetlands were originally formed by sand and gravel mining that left a pit 30 feet deep in the center. This was a trap for sediments. Also, invasive species dominated the upper slopes and algae blooms were significant. The pond receives tributary flows from the west, which, during rain events, includes urban stormwater flows. The restoration focus here was to improve sediment transport and provide additional wetland area for filtration and habitat. Approximately 80 percent of the East Pond was filled. Recycled riprap from excavated concrete was placed on the face of the soil fills to hold the soil in place during storm events. Wetland plantings were also completed in this step to help filter pollutants.
3. Channel restoration: A constriction in the river channel constructed after the floods of the 1970s and 1980s to protect a sand mining operation was aggravated by sediment deposits over time. The river channel was only 30 feet wide. The work was to improve flood management and lower the 100-year flood levels by widening the floodway to at least 100 feet. The County required the new cut slope to have riprap to the 100-year flood level to stabilize the slope under the velocities of a major flood event. All the riprap on the slope was recycled from the excavation, and included rock and large concrete slabs that were broken up onsite. More than 500 native shrubs and trees were planted every 10 feet throughout the riprap. These plantings provide green cover over the slope.
4. Constructed wetlands: The constructed wetland was designed to further cleanse the pollutants from tributary flows from the west that carry stormwater and urban runoff. About 65,000 cubic yards were excavated to form two treatment cells. The water must travel through treatment systems in both cells before it can recharge the groundwater or discharge back into the river below the channel mouth. In the first cell, wetland vegetation provides natural filtration. The second cell is designed to encourage groundwater infiltration and to direct the flow of stormwater into the channel.
5. Bioswale: The southwestern corner of the project area, adjacent to State Highway 67, receives urban runoff from a watershed south of Highway 67. Bioswales are used to treat the runoff before it flows into the southwestern corner of the West Pond. Retention time is the key to effective natural treatment in

the bioswale. Several pond areas receive and retain flows before the water flows to the next level. On the east, a narrow mature line of cottonwood, willow, and mulefat scrub treats the water. To the west, a new connection retains water briefly before it flows into the shallow thicket of young cottonwoods and willows. These trees treat the water before it slowly flows through the newly excavated treatment area. The two streams join again just before entering the western channel wetlands.

Phase II consisted of removing approximately 400,000 cubic yards of fill to create an area designed to slow floodwaters and provide additional habitat; this area is called the West Meadow. In Phase II, Caltrans excavated and removed fill west of the constructed wetland to construct the extension of State Route 52 to Highway 67. Approximately 400,000 cubic yards of fill were removed from the project area. This created new transitory storage and decreased flood levels in the 100-year event. It also increased riparian habitat.

Success Factors:

In January 2008, the project was recognized by the SWRCB as a success story in treating urban runoff and restoring the integrity of the river.

There are many factors that contributed to the success of this FM/IWM project. Unique factors are discussed here.

Tenacity for the Project: Project proponents attribute the sustained success of this project to the tenacity and commitment of those involved in the work. Passionate advocates for the project persevered through various challenges, such as funding delays and complex permitting processes. Volunteer support and community service work programs also played an integral role in the success of the project. In total, 23,600 volunteer and work program hours have been logged, engaging in invasive species eradication, planting native species, weeding, patrolling, and general support in a number of administrative areas.

Role of Project Partners: Phase II of the project was made possible when Caltrans became a partner and performed fill removal necessary for the project, and used this fill to meet their own construction needs. This collaborative element resulted in a net savings for both parties.

Phased Project Approach: Splitting the project into phases had several benefits. To be successful, the revegetation program required a phased, multi-year approach to prepare the earth for a healthy native species population that could withstand significant quantities of invasive species. Dewatering the project site during Phase I enabled accurate excavation elevations to be determined for the Phase II transitory storage element. Phased project efforts could be aligned with the grant funding that tended to fluctuate. Several project adjustments occurred in response to observations of actual field conditions and agency input. This resulted in project performance improvements and increased project benefits.

Compatibility with Regional Efforts: Efforts to restore the San Diego River are not exclusive to Lakeside. The San Diego River Park concept is an ambitious undertaking that will establish a linear River Park along the urban and rural sections of the San Diego River from the Pacific Ocean to the river's headwaters near Julian, California. The management organizational structure for the river park includes a coalition of 50 community-based land conservancies and friends groups that will manage river restoration and park activities in partnership with the San Diego River Park Foundation and the San Diego River Conservancy.

Integrated Management Actions

The project encompassed structural and nonstructural flood management and restoration actions that were integrated to achieve multiple benefits. The primary actions include:

- Acquiring ownership or land tenure on property for preservation or restoration as protected habitat. LRPC has acquired land through purchases from willing sellers and through land donations.
- Widening of the river (from 30 feet to 100 feet) into a portion of its historical floodplain.
- Restoring the natural meanders of the river channel.
- Reconfiguring tributary discharge points through the use of passive engineering techniques, which will slow flood velocities and divert those flows into a restored meander system.
- Restoring riparian habitat types for several threatened and endangered species.
- Capturing transient flood flows for habitat (wetland) enhancement and for groundwater recharge enhancement. The amount of recharge is increased to local aquifers that feed water supply to municipal wells. Recharge is accomplished through the use of former gravel mining pits for floodwater detention and groundwater recharge.
- Lowering the stream channel to its normal flood management level. This required removal of 400,000 cubic yards of sediment and debris.
- Adding approximately 1 mile of publicly accessible new river trails along the banks of the newly restored river channel. The success of the trail system was largely a result of generous property donations and extensive volunteer work.

Integrated Benefits

The LRPC project is a multifaceted, multiple objective effort. The project provides flood protection, habitat, recreation, water quality, and supply benefits.

Flood benefit: Primary flood benefits include reduced flood levels, prevention of urban development in a floodplain that is subject to development pressure, improved sediment balance, and protection of downstream bridges and water pipeline.

Environmental benefits: Environmental benefits include restoring and preserving habitat, and preventing use of the land for ranchette development or other use that would be incompatible with the floodplain and habitat value of the site. The project created, restored, and enhanced more than 90 acres of habitat for threatened and endangered species, and it improved downstream water quality with the creation of the constructed wetlands and the bioswale.

Water supply benefits: The constructed wetlands treats urban runoff and allows it to recharge into the aquifer, increasing groundwater storage, which supports municipal wells important to the local community.

Recreation benefits: The project includes camping areas, trails, and a boardwalk in the pond with access for the disabled and interpretive educational information.

Other benefits: Fill material from channel excavation was used for transportation needs (Highway 52 project). Volunteer involvement in the project increased community awareness of the importance of a natural river system that can function in a safe and beneficial way. The project also affords educational opportunities for students and community members.

Financial Information and Project Status

The project was initiated in 2004 and completed in 2010. LRPC received funding from various sources for the project, including:

- Private parties, foundations, nongovernmental organizations, and business partnerships: $473,000
- California Coastal Conservancy: $800,000
- Wildlife Conservation Board: $4,800,000
- California Resources River Parkways Program (Proposition 40): $4,200,000
- California DWR Flood Protection Corridor Program (Proposition 13): $4,139,000
- California DWR Flood Protection Corridor Program (Proposition 84): $3,229,000
- State Water Resources Control Board (Proposition 13): $1,105,700
- Regional Water Quality Control Board (Proposition 13): $1,291,000
- California Natural Resources Agency and Caltrans Environmental Enhancement and Mitigation Program: $250,000
- California River Parkways Grant Program: $200,000

This totals approximately $20.5 million in funding. The grants LRPC obtained supported the following actions:

- Property acquisition was made possible in 2004 using California State Coastal Conservancy, Wildlife Conservation Board, Proposition 40, and DWR Flood Protection Corridor funding.
- Restoration to reclaim river functions and further the San Diego River Watershed Management Plan objectives was funded by two Proposition 13 grants from the SWRCB and a restoration portion incorporated into the DWR Flood Protection Corridor Grant.
- A Constructed Wetland Grant and an Excavation and Water Quality Grant from the SWRCB, in combination with a second DWR Flood Corridor Protection Grant, funded project elements that addressed flood management, habitat restoration, and water quality.

Primary Information Sources

County of San Diego. *Final Environmental Impact Report: Upper San Diego River Improvement Project.* August 2000.

Lakeside's River Park Conservancy. *Flood Management, Habitat, Restoration, and Recharge on the San Diego River, Final Report.* April 28, 2010.

Lakeside's River Park Conservancy. *Project Summary, Proposition 84 Flood Protection Corridor Program.* 2008.

Lakeside's River Park Conservancy. "Background of the Project." Available on Web site: www.lakesideriverpark.org/About/background.htm. Accessed on February 23, 2012.

San Diego River Park Conservancy/Lakeside's River Park Conservancy. *Project Application for the Proposition 13 Flood Protection Corridor Program*. 2003.

Appendix F: Glossary

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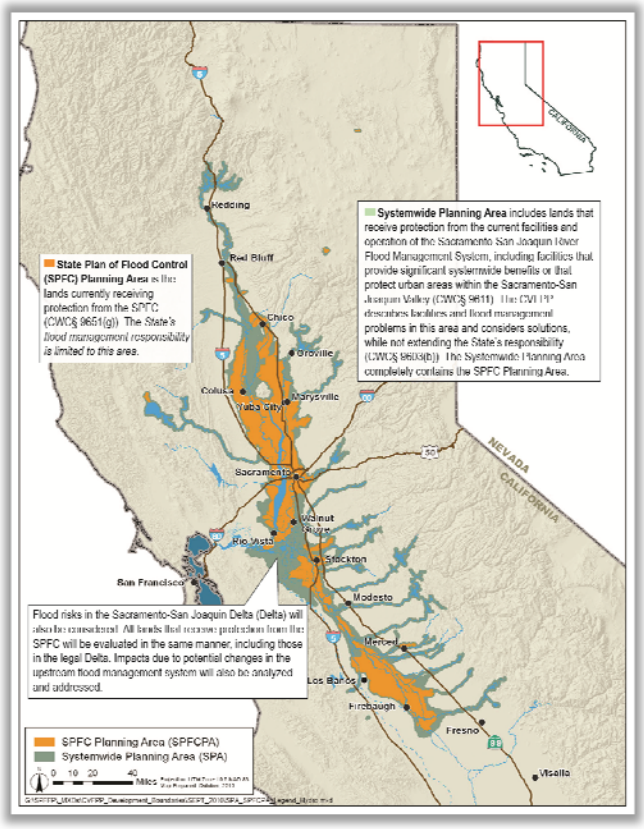
Appendix F: Glossary

2-year event	50 percent chance of exceedance in a given year
20-year event	5 percent chance of exceedance in a given year
50-year event	2 percent chance of exceedance in a given year
100-year event	(also known as a base flood) 1 percent chance of exceedance in a given year
200-year event	0.5 percent chance of exceedance in a given year
500-year event	0.2 percent chance of exceedance in a given year
A-Zone	The A-zone is an area of special flood hazard without water surface elevations determined. Flood insurance is mandatory in areas with a 1 percent annual chance of flooding.
Actions	Informed by tools and guided by plans, actions include activities that fund, manage, and oversee implementation of the projects. Actions also include fostering innovation and developing agency alignment to improve flood management policies, planning, governance, and investments. Actions based on IWM principles and thorough planning efforts will provide the most benefit to Californians.
Alluvial Fan Flooding	Flows of shallow depth and high velocity, with sediment transport, along uncertain flow paths on the surface and at the toe of alluvial fans. Typically caused by localized rainstorms, often with snowmelt.
Atmospheric River	A weather pattern that forms a narrow corridor of concentrated moisture in the atmosphere that drops torrential rains as it passes over land.
Base Flood Elevation	The elevation of surface water resulting from a flood that has a 1 percent chance of equaling or exceeding that level in any given year. The base flood elevation is shown on Flood Insurance Rate Maps for zones AE, AH, A1-A30, AR, AR/A, AR/AE, AR/A1–A30, AR/AH, AR/AO, V1–V30, and VE.
Benefit-to-Cost (B/C) Analysis	The B/C analysis is a formalized procedure for estimating the benefits that a project is expected to generate and the costs necessary to produce the project, and then comparing project alternatives. When planning for flood protection, there will be construction and implementation costs, as well as flood risk reduction benefits.
California Data Exchange Center (CDEC)	The CDEC provides a centralized location to store and process real-time hydrologic information gathered from different contributors statewide.
California Water Plan (CWP)	The CWP provides a collaborative planning framework for elected officials, agencies, tribes, water and resource managers, businesses, academia, stakeholders, and the public to develop findings and recommendations and make informed decisions for California's water future. The plan, updated every 5 years, presents the status and trends of California's water-dependent natural resources; water supplies; and agricultural, urban, and environmental water demands for a range of plausible future scenarios. The CWP also evaluates different combinations of regional and statewide resource management strategies to reduce water demand, increase water supply, reduce flood risk, improve water quality, and enhance environmental and resource stewardship.

Capacity Exceedance	Capacity exceedance implies exceedance of the capacity of a water conveyance, storage facility, or damage-reduction measure. This includes levee or reservoir capacity exceeded before overtopping, channel capacity exceedance, or rise of water above the level of raised structures.
Central Valley Flood Management Planning (CVFMP) Program	CVFMP is one program within FloodSAFE California, a multi-year initiative led and managed by the California Department of Water Resources. Primary products of the CVFMP Program are the State Plan of Flood Control Descriptive Document, the State Plan of Flood Control History Document, the Flood Control System Status Report, and the Central Valley Flood Protection Plan.
Central Valley Flood Protection Plan (CVFPP)	The CVFPP is a State plan that will describe the challenges, opportunities, and a vision for improving flood management in the context of Integrated Water Management in the Central Valley. The CVFPP will document the current and future risks associated with flooding and recommend improvements to the Federal-State flood protection system to reduce the occurrence of major flooding and the consequence of flood damage that could result. The plan was submitted to the Central Valley Flood Protection Board in January 2012 for adoption by July and will be updated every 5 years. The planning area for the CVFPP is shown below.



Central Valley Flood Protection Plan (CVFPP) Floodplain	The floodplains used for the SFMP risk characterization within portions the Central Valley are the CVFPP No Action depth grid floodplains with the addition of the flood bypasses. SFMP received the draft CVFPP floodplains on October 4, 2011. The CVFPP floodplains were based on the floodplains of the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE, 2002) and modified by the CVFPP to reflect current hydrologic, hydraulic, and geotechnical information. For the SFMP analysis, the Yolo, East Side, Upper Sacramento, Mariposa, Sutter, and Tisdale bypasses were added to the CVFPP floodplains.
Coastal Flooding	Inundation at locations normally above the level of high tide. Often caused by storm surges occurring with high tides. Impacts include property damage and beach erosion.
Community	A political entity that has the authority to adopt and enforce floodplain ordinances for the area under its jurisdiction.
Consequences	Consequences are the quantitative measures of loss, such as direct tangible monetary loss or number of lives lost, when water inundates the people and property exposed.
Critical Facilities	Essential, high potential loss, lifeline, and transportation facilities, as defined by HAZUS-point shapefiles
Debris Flow Flooding	Flows made up of water, liquefied mud, and debris. Can form and accelerate quickly, reach high velocities, and travel great distances. Commonly caused by heavy localized rainfall on hillsides denuded of vegetation.
Economic Risk	Economic risk is the likelihood of flood damage to an identified area under a given climate and land use condition.
Engineered Structure Failure Flooding	Flooding as a result of dam failure or levee failure presents the potential of catastrophic impact, depending on amount of water impounded and location of populated areas downstream.
Essential Facilities	Care facilities, emergency centers, fire stations, police stations, and schools, as defined by HAZUS-point shapefiles.
Expected Annual Damage (EAD)	EAD is the value that measures the severity of flood loss in any given year. EAD does not mean that this amount of damage will occur in any particular year, but rather that over a long period, the average damages will tend to approach that amount.
Exposure	Exposure is a description of who or what is in harm's way.
Fetch	The distance along open water or land over which the wind blows, or the distance waves can traverse unobstructed.
Flash Flooding	Quickly forming floods with high-velocity flows. Often caused by stationary or slow-moving storms. Typically occurs on steep slopes and impermeable surfaces, and in areas adjacent to local streams and creeks.

Flood Emergency Response Information System (FERIS)	FERIS is a geospatial information system that allows for integration of existing California Data Exchange Center (CDEC) systems with real-time data collection and data exchange.
Flood Hazard	The Federal Emergency Management Agency defines a flood hazard as any flood event or condition with the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, environmental damage, business interruption, or other loss.
Flood Insurance Rate Map (FIRM)	A FIRM is the official map of a community on which the Federal Emergency Management Agency has delineated the Special Flood Hazard Areas, the Base Flood Elevations, and the risk premium zones applicable to the community.
Flood Management	See *flood risk management*. Generally, the terms *flood management* and *flood risk management* are used interchangeably throughout the Flood Future Report.
Flood Risk	Flood risk is the likelihood of consequence of inundation within an identified area, given a specified climate condition, land use condition, and flood management system (existing or planned) in place. The consequence may be direct or indirect economic cost, loss of life, environmental impact, or other specified measure of flood effect. Flood risk is a function of the following components: • Loading, which is the frequency and magnitude of flooding • Performance of flood management measures • Exposure and vulnerability, which are the relationship between the flood hazard (rising or flowing water) and its effect on life loss, property, and/or environmental resources • Consequence Therefore, flood management actions may reduce risk by changing loading, performance, exposure, vulnerability, or consequence.
Flood Risk Management	Flood risk management seeks to reduce flood risks by managing the floodwaters to reduce the probability of flooding (including by levees and dams) and by managing the floodplains to reduce the consequences of flooding. Flood risk management requires integrating and synchronizing programs at various levels of government designed to reduce flood risk. Source: USACE, Institute for Water Resources, a dynamic resource at http://nfrmp.us/frm_terminology.cfm#def17 (accessed March 11, 2013).
Floodplain	The extent of the flood hazard for a 100-year (1 percent chance of exceedance in a given year) or 500-year (0.2 percent chance of exceedance in a given year) event, as determined by CVFPP, FEMA, or USACE.

FloodSAFE California	FloodSAFE California refers to the California Department of Water Resources multi-faceted initiative launched in 2006 to improve public safety through flood management in the context of Integrated Water Management and to reduce potential flood damages in areas of the state with the highest risk. Although led at the State level and initially funded by bond money from Propositions 1E and 84, FloodSAFE implementation relies on the cooperation and assistance of Federal partners, Tribal entities, local sponsors, and other stakeholders. The FloodSAFE vision is a sustainable system of flood management with an IWM approach and emergency response throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding.
Hazard Mitigation Plan (HMP)	A community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage is described in an HMP. Results are accomplished through hazard mitigation, which is any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.
Hazards United States (HAZUS) – Federal Emergency Management Agency (FEMA)	FEMA has developed this Geographic Information System-based U.S. multihazard assessment software, which contains a Flood Loss Estimation Model with flood hazard analysis and flood loss estimation modules for riverine and coastal analyses. The flood hazard analysis module uses characteristics such as frequency, discharge, and ground elevation to estimate flood depth, flood elevation, and flow velocity.
High Potential Loss Facility	Facilities such as dams and hazardous material sites, as defined by HAZUS-point shapefiles.
Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA)	The U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC) Flood Damage Analysis (FDA) model is designed to perform risk analysis as part of a flood risk study. The approach explicitly incorporates descriptions of uncertainty of key parameters and functions into project benefit and performance analyses.
Hydrologic Unit Code 8 (HUC8)	A Hydrologic Unit Code 8 is a watershed address consisting of a name and a number (for example, Lower James watershed, 02080206). The 8-digit number is a Hydrologic Unit Code or HUC. The Hydrologic Unit system is a standardized watershed classification system developed by the U.S. Geological Survey in the mid-1970s. Hydrologic units are watershed boundaries organized in a nested hierarchy by size. They range in size from regions to the smaller cataloging units, which are roughly equivalent to local watersheds.
Impact Area	Impact area is a term used for convenience to describe a geographic area for which risk is assessed.
Improvement Project	A Project that will improve or add facilities to the State Plan of Flood Control to increase levels of flood protection for urban areas. Funding for improvement projects is authorized by California Public Resources Code § 5096.821(b).

Integrated Regional Water Management (IRWM)	IRWM promotes the coordinated development and management of water, land, and related resources to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.
Integrated Water Management (IWM)	IWM is a strategic approach to planning and implementation that combines specific flood management, water supply, and ecosystem actions to deliver multiple benefits. IWM relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental sciences, public policy, and public information. This approach also promotes system flexibility and resiliency to accommodate changing conditions such as regional preferences, ecosystem needs, climate change, flood or drought events, and financing capabilities.
Life-Safety Risk	Life-safety risk represents the number of lives in jeopardy in an identified portion of the state, considering a given climate and land use condition, with a specified plan of flood management in place.
Loading	In the context of flood risk, loading describes the likelihood of occurrence of conditions that lead to loss of life or damage to property if the conditions are not controlled or the consequence is not managed. Loading commonly is described with a discharge-frequency function, which identifies the probability that discharge at a specified location will exceed a specified value.
Local Maintaining Agency (LMA)	LMAs include reclamation districts, State maintaining agencies, improvement districts, and individual districts like American River Flood Control District or Lower San Joaquin Levee District.
Long-Term Average (or Expected) Annual Inundation Damage	See Expected Annual Damage (EAD).
Maintenance and Inspection	Actions required for the proper care and efficient operation of various project elements. These actions may be combined or separated, as best suits the particular project. The guidance for proper maintenance and inspection are contained in ER 1130-2-303. Adaptations needed to satisfy conditions not covered in the ER are encouraged. Outlines of the maintenance and inspection records are be maintained and available for Government inspection. Government inspections will be performed in consultation with the project's sponsor. (Source: ER 1110-2-401)
Management Action	A management action is a specific structural or nonstructural strategy, action, or tactic that contributes to stated goals and addresses identified problems. Management actions could range from potential policy or institutional changes to operational and physical changes to the flood management system. Management actions are broad (not location-specific), and they vary in their level of detail.

Modification	Project modifications include changes in project operation, changes in real estate interests, the physical change of a project feature, addition of project features, or changes in the purposes of a project. (Source ER 1165-2-119)
National Flood Insurance Program (NFIP)	The NFIP is a Federal program created by the U.S. Congress to mitigate future flood losses nationwide. The NFIP requires local communities to enforce building and zoning ordinances in exchange for access to affordable, Federally backed, flood insurance protection for property owners.
Operation	Actions that are necessary for the safe and efficient functioning of a project to produce the benefits set forth in the project authorization. The operational requirements for nonreservoir projects are to be presented as operation plans covering essentially the who, what, where, when, and how of the various project operations. An outline of operation records is to be maintained and available for inspection. The operation of reservoirs, covered in water control manuals shall be separate from this operation and maintenance manual. (Source: ER 1110-2-401)
Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)	For Federally funded projects the definition of operation and maintenance (O&M) includes the local entity's financial obligation to operate, maintain, repair, rehabilitate, and replace (OMRR&R) the implemented project. OMRR&R is a non-Federal responsibility when local, regional and/or State entities partner on a Federal project. References to O&M provided in the Flood Future Report include OMRR&R responsibilities when the project is a Federal/non-Federal partnership.
Performance	Performance refers to the effectiveness of flood or floodplain management measures.
Plans	Plans utilize information provided by tools, as well as input from stakeholders to guide the development of the flood management strategies. Plans take into account near- and long-term actions, as well as any additional considerations, such as multiple benefits, environmental concerns, overall water management, and climate change, to formulate long-lasting resilient strategies. Plans include identifying and evaluating possible multibenefit projects and the most effective means of implementing projects using an integrated, collaborative approach.
Project Management Plan	A project management plan defines how a project is executed, monitored, and controlled. It is used to define the approach, scope, and delivery of a project.
Public Resources Code Section 75003.5	The people of California further find and declare that the growth in population of the State and the impacts of climate change pose significant challenges. These challenges must be addressed through careful planning and through improvements in land use and water management that both reduce contributions to global warming and improve the adaptability of our water and flood control systems. Improvements include better integration of water supply, water quality, flood control and ecosystem protection, as well greater water use efficiency and conservation to reduce energy consumption.

Public Resources Code Section 75032(a)	Public Resources Code Section 75032(a) provides funds for: The inspection and evaluation of the integrity and capability of existing flood control project facilities and the development of an economically viable flood control rehabilitation plan.
Reconstruction	Reconstruction consists of addressing the major performance deficiencies caused by a long-term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform its authorized project functions. (Source: USACE, Program Guidance Letter on Reconstruction, August 16, 2005, http://planning.usace.army.mil/toolbox/library/MemosandLetters/reconstruction.pdf)
Rehabilitation	Rehabilitation refers to a set of activities necessary to bring a deteriorated project back to its original condition. (Source: ER 1110-2-401)
Repair	Repair refers to those activities of a routine nature that maintain the project in a well kept condition. (Source: ER 1110-2-401)
Replacement	Replacement covers those activities taken when a worn-out element or portion of a project is replaced. (Source: ER 1110-2-401)
Residual Risk	Residual risk is the likelihood of damage or other adverse consequence remaining after flood management actions are taken.
Results	Robust tools, thorough planning, and integrated actions deliver results that provide value to California's residents, environment, and economy. Results are tracked using performance measures and sustainability indicators that help improve investment performance and increase flood management benefits.
Severe Repetitive Loss (SRL)	Any NFIP-insured residential property that has met at least one of the following paid flood loss criteria since 1978, regardless of ownership: • Four or more separate claim payments of more than $5,000 each (including building and contents payments) • Two or more separate claim payments (building payments only) where the total of the payments exceeds the current value of the property In either case, two of the claim payments must have occurred within 10 years of each other. Multiple losses at the same location within 10 days of each other are counted as one loss, with the payment amounts added together. The loss history includes all ownership of the property since 1978 or since the building's construction if built after 1978.
Slow Rise Flooding	Slow rise flooding occurs as a gradual inundation as waterways or lakes overflow their banks. Most often caused by heavy precipitation, especially with heavy snowmelt. Includes riverine flooding in deep floodplains and ponding of water in low-lying urban areas, as well as gradual flooding in areas adjacent to local streams and creeks.
Special Flood Hazard Area (SFHA)	SFHAs are areas subject to inundation from a flood that has a 1 percent chance of being equaled or exceeded in a given year.

State Plan of Flood Control (SPFC)	Collectively, the facilities, lands, programs, conditions, and mode of operation and maintenance for the State-Federal flood protection system in the Central Valley. This area is shown in the figure provided under CVFPP definition.
Tools	Tools include data, models, and assessments needed for decision making in all aspects of flood management. DWR continues enhancing and sharing technical resources (tools) across all programs and projects. This includes flood, environmental, and water management data gathering, modeling, and the technical aspects of flood readiness and emergency response. Technical and modeling information help inform thorough and thoughtful planning, along with accurate design of flood management facilities.
Transportation Facility	Runways, railway bridges, rail facilities, port facilities, light-rail facilities, highway bridges, ferry facilities, bus facilities, and airport facilities, as defined by HAZUS-point shapefiles.
Tsunami Flooding	Tsunami flooding occurs as a result of high-speed ocean waves triggered by mass movement that displaces a large volume of water. Causes include earthquakes and underwater landslides. Impact on land depends on wave height and inundation area.
Utilities	Wastewater, potable water, oil, natural gas, electric power, and communications facilities, as defined by HAZUS-point shapefiles.
V-Zone	The V-zone is an area inundated by 1 percent annual chance (100-year) flooding with velocity hazard (wave action); no base flood elevations have been determined.
Vulnerability	Vulnerability is the susceptibility to loss or damage of people and property exposed to the flood hazard.
Water Data Library (WDL)	The WDL is a searchable Geographic Information System (GIS) interface on the Internet. WDL allows users to access information about monitoring gauges, groundwater data, and water quality.

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The complete report, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, including technical attachments and other supporting information is available for review at:

http://www.water.ca.gov/SFMP